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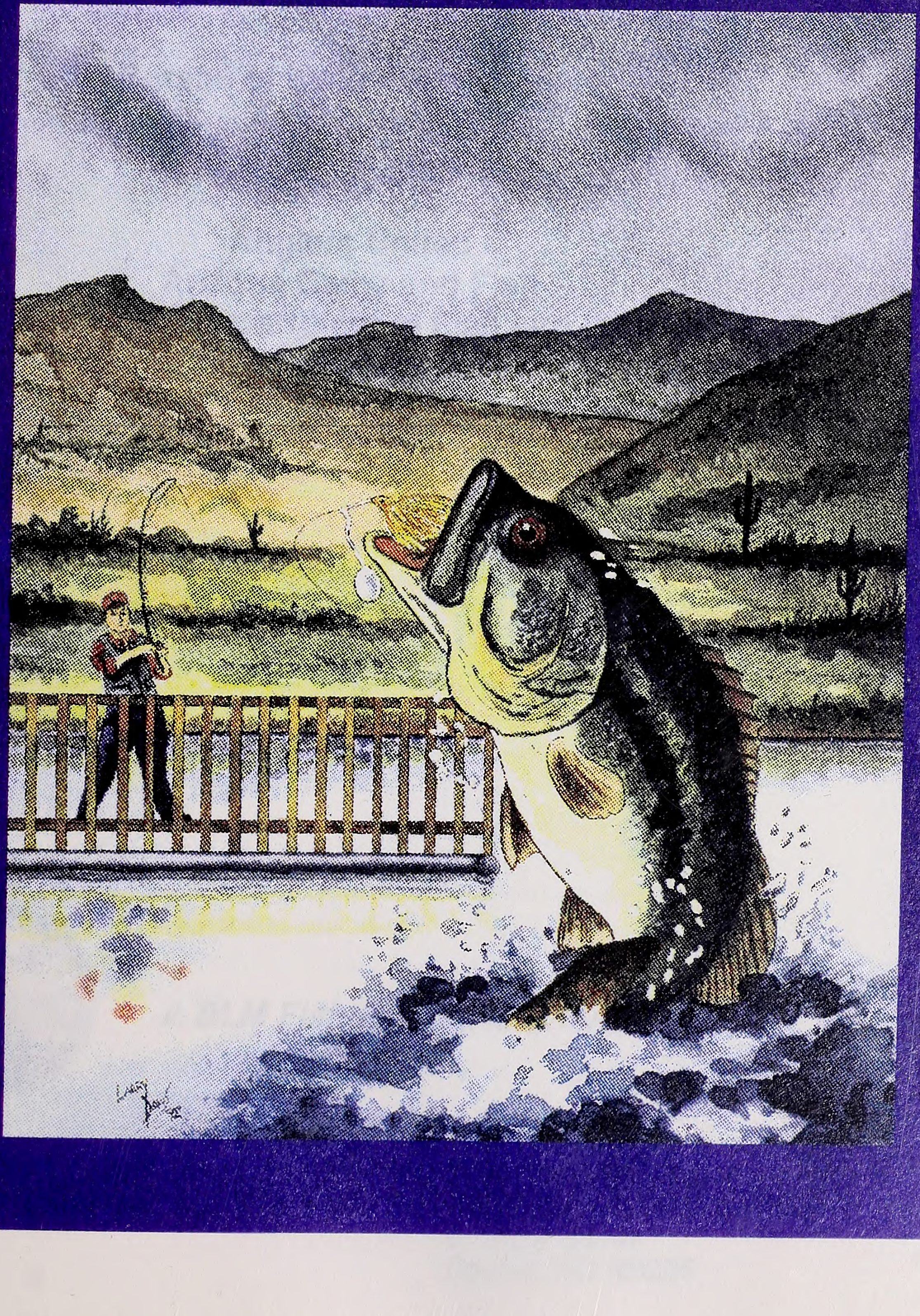
# LAKE HAVASU FISHERIES IMPROVEMENT

## A PARTNERSHIP PROGRAM



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# LAKE HAVASU
# FISHERIES IMPROVEMENT

## A PARTNERSHIP PROGRAM

**Prepared by**

**Bureau of Land Management**

**in cooperation with**

**Anglers United**
**Arizona Game and Fish**
**California Department of Fish and Game**
**Bureau of Reclamation**

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# EXECUTIVE SUMMARY

The Lake Havasu Fisheries Improvement Program is the largest and most comprehensive warm water fisheries project ever undertaken in the United States. In addition to enhancing a vital fishery, the program addresses the recreational needs of the boating and non-boating public.

Located along the Arizona-California border, Lake Havasu is the most heavily used lake on the Colorado River and in Arizona. However, fishing accounts for a relatively small amount of the activity. Populations of native fish which used to be abundant in the Colorado River have all but disappeared. Availability of game fish, which provide recreational fishing opportunities, have steadily declined. Once recognized as one of the most productive lakes on the Colorado River, Lake Havasu now needs habitat improvement.

Access to Lake Havasu is very limited without a boat. Where the public can get to the shoreline, there are no developed trails, docks, or other facilities.

The objective of the Lake Havasu Fisheries Improvement Program is to increase fish populations in the lake and provide recreational opportunities for thousands of fishing enthusiasts by:

1. Placing artificial habitat in selected coves of the lake, increasing the availability of game fish and improving angler catch rates.

2. Reducing predation on young native fish by raising them in specially protected coves.

3. Increasing access to the lake through construction of foot trails and fishing docks for both the non-boating angler and the physically challenged.

4. Providing necessary support facilities to accomodate recreationists. These include access roads, parking areas, restrooms, fish cleaning stations, picnic areas, and interpretive facilities.

The project began in spring of 1992 and will take several years to complete. Habitat enhancement will occur on both the Arizona and California sides of the lake.

For planning purposes, the lake is split into six segments. Habitat structures will be placed in as many as 42 coves and associated points. A variety of artificial habitats designed to benefit the target game fish species (largemouth bass, channel catfish, striped bass, crappie, and bluegill) will be used. Five basic types of structures are planned and will be dropped overboard from a boat into water depths of up to 25 feet.

Protection of "grow out" coves for native fish will begin in 1993. A specially constructed net will keep predatory fish out of the cove while razorback suckers and bonytail chub are raised within the cove. These fish will be released into the lake when they reach 12 to 16 inches in length.

At least six sites will be developed for shoreline fishing access, in addition to fish habitat improvements. These will range from major recreation sites with facilities including paved shoreline trails, fishing docks, restrooms, and fish cleaning stations, to less developed access sites with gravel trails and parking areas. These sites will provide year-round angling opportunities for all shore-based recreationists.

The Lake Havasu Fisheries Improvement Project is a joint venture between the Bureau of Land Management, Anglers United, Arizona Game and Fish Department, California Department of Fish and Game, and the Bureau of Reclamation. Additional cooperators include Arizona State Parks, the U.S. Fish and Wildlife Service, Lake Havasu City Parks and Recreation Department, Metropolitan Water District and local bass clubs.

Estimated cost of the program is more than $27 million. This does not include special equipment or future maintenance needs. Costs will be shared as much as possible by all cooperating agencies, but funding will be needed from many other public and private sources. This cost represents a large investment; however, the project has the potential to return $3.5 million annually to the local economy. As early stages of the project are completed, contributions will be acknowledged by even larger numbers of the recreating public. This in turn is expected to attract more contributions. The opportunities to showcase accomplishments and partnerships are infinite.

# LAKE HAVASU NATIVE FISH MANAGEMENT PLAN

The Lake Havasu Fisheries Improvement Program is primarily directed towards improvement of recreational fishing opportunities in Lake Havasu. However, this project also presents a unique opportunity for the cooperative recovery of endangered species of native fish.

Four native fish species, now listed as endangered, once occurred in the Colorado River where Lake Havasu now lies. Alterations in the river through construction of dams and impoundments, introduction of non-native fish species, and other factors have vastly reduced or eliminated these fish from much of the lower Colorado River. Native fish management in Lake Havasu will focus on two of these species, the razorback sucker and bonytail chub.

Although a variety of factors may be limiting successful repopulation of these species, predation by non-native fish is believed to be a major factor. Since populations of game fish are expected to increase in Lake Havasu as a result of artificial habitat development, some form of protection of native fish in the lake is required. This plan provides a means to eliminate the predation factor during a vulnerable period of the life cycle of these fish, allowing their populations to increase in Lake Havasu. In addition, by establishing a population of these fish in Lake Havasu, the likelihood of imminent extinction would be reduced. Biologists would have more time to conduct further research on other limiting factors for these species and develop additional techniques for their recovery.

Costs of native fish management would be shared as much as possible by the U.S. Fish and Wildlife Service, Bureau of Land Management, Bureau of Reclamation, Arizona Game and Fish Department, and California Department of Fish and Game.

## GROW OUT COVES

In order to protect young native fish from predation and increase the number of these fish released into Lake Havasu, grow out coves will be established. A barrier net will be constructed across the mouth of a cove and as many of the game fish in the cove removed as possible. Young hatchery spawned razorback suckers and bonytail chub will be introduced to the cove and grown to a total length of 12 to 16 inches, when they will be released. The objective is to release 30,000 razorback suckers and 30,000 bonytail chub into Lake Havasu from grow out coves in the next ten years. Grow out coves will be developed concurrently with other habitat enhancement projects in the lake. The number of coves developed for native fish will depend on an evaluation of the success of the project through annual monitoring surveys of fish in Lake Havasu.

# LAKE HAVASU FISHERIES IMPROVEMENT PROGRAM

## INTRODUCTION

Lake Havasu was formed in 1938 as a result of the construction of Parker Dam on the Lower Colorado River. The reservoir was created to provide a settling basin and diversion point for Southern California's Metropolitan Water District. Located along the Arizona-California border, it consists of approximately 20,400 surface acres. Lake Havasu is normally operated at a water level of 446-450 feet elevation above mean sea level. Annual fluctuations rarely exceed four vertical feet. At full capacity, the impoundment holds 619,400 acre-feet of water and the shoreline extends more than 100 miles.

Intensive fish management activities for Lake Havasu have remained relatively passive since the introduction of threadfin shad and striped bass in the 1950s and 1960s. Fisheries surveys have documented angler utilization and relative abundance of warmwater fish species such as largemouth bass, channel catfish, striped bass, bluegill, and crappie (target species). The catch rate for anglers on Lake Havasu is estimated to be one target fish for every five hours spent fishing. Good fishing is considered at least one fish per hour. One four hour period spent fishing is considered an Angler Use Day. Based on a 1989 survey, Angler Use Days were estimated to be over 43,000 days for Lake Havasu with 70 percent of anglers fishing for striped bass (Marzuola et al. 1990).

While 43,000 days seems like a lot, this figure is equalled by Arizona lakes one tenth the size of Lake Havasu. There are two obvious reasons for this. First, condition factors for the target species are only average compared with other Arizona reservoirs. Growth rates also are only fair. Fish hiding and rearing cover is almost non-existent. The Arizona Game and Fish Department has identified existing bottom cover of less than ten percent as a limiting factor.

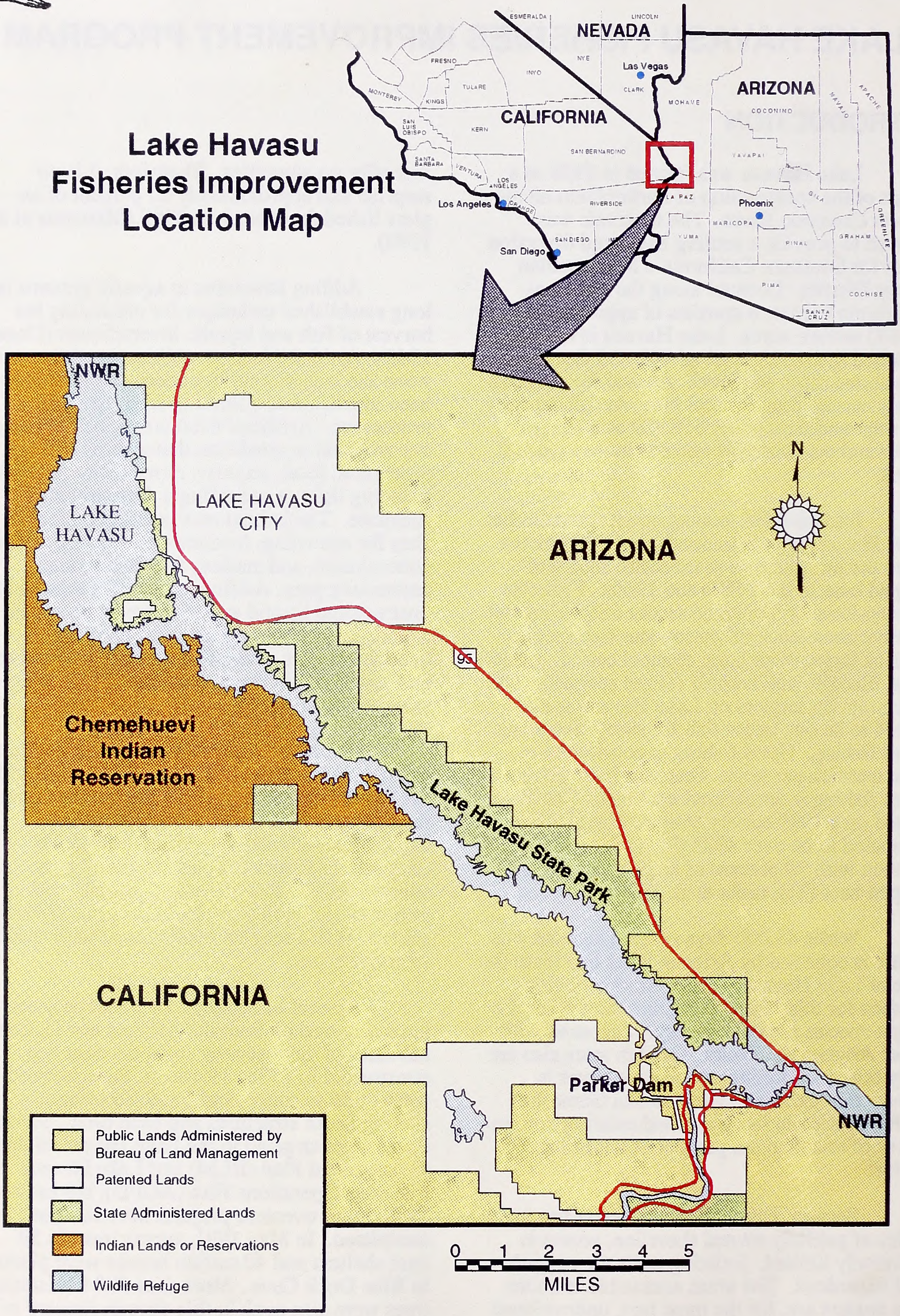
Second, although the reservoir has many miles of publicly owned shoreline, access is extremely limited. Existing trails are rugged and hazardous. The areas accessible to shoreline anglers are, for the most part, undeveloped and offer no amenities. Therefore, it is no surprise that approximately 85 percent of anglers fished from boats in 1989 (Marzuola et al. 1990).

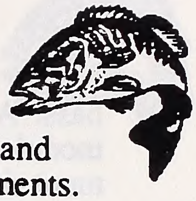
Adding structures to aquatic systems is a long established technique for enhancing the harvest of fish and aquatic invertebrates (Unger, 1966). Artificial habitat addition is often used when the lack of natural underwater habitat has been identified as a limiting factor for fish production. Artificial habitat may be defined as any material or condition that affords fish protection, food, security, or reference points by reducing light or providing a discontinuous substrate. The habitat may provide preferred sites for spawning, locations for resting, refuge, concealment, and stations for feeding and ambushing prey. Adding habitat to a relatively unstructured littoral zone (an area with rooted aquatic vegetation) appears to improve fish habitat and may also improve local productivity and growth (Prince and Maughan 1979, Wege and Anderson 1979).

For cover-dependent centrarchids (bass and sunfish), artificial habitat additions provide life requirements through all life phases rather than serve simply as attractors to increase exploitation of catchable-sized individuals (Brouha, Paul, and C.E. von Geldern, pers. comm., 1979). Reproduction, growth, and mortality (including angler harvest) of different species of fish may be manipulated with specific structure types.

Several habitat improvement projects have occurred on both the Arizona and California sides of the reservoir since the dam was constructed in 1938. However, these projects were small in scope, and involved primarily sinking brush structures and used tires. Several coves were targeted in the Lake Havasu Habitat Management Plan (BLM) and Lake Havasu Fisheries Operations Plan (AGFD), but most habitat improvement projects have not been completed. In May 1991, approximately 50 bass shelters and 40 catfish houses were placed in Blue Dock Cove. More than 500 Christmas trees were also sunk in this cove in January of

# Lake Havasu Fisheries Improvement Location Map





the same year. Monitoring of Blue Dock Cove by the Arizona Game and Fish Department has demonstrated the success of these artificial habitats in attracting targeted fish species.

## THE PROGRAM PLAN

In late 1991, the U.S. Bureau of Land Management (BLM), in cooperation with Arizona Game and Fish Department (AGFD), California Department of Fish and Game (CDFG), U.S. Bureau of Reclamation (BR), and the private group, Anglers United, formed a team to determine the feasibility of enhancing the fishery of Lake Havasu. The following objectives were formulated:

1. Increase target fish production.

2. Improve shoreline access for the non-boating public.

3. Provide the necessary support facilities to accommodate the angling public.

With these objectives in mind, the "Lake Havasu Fisheries Improvement Program" was developed. For planning purposes, the reservoir is divided into six segments (see map). In each segment, one to three potential access points were identified or proposed for development, and four to nine areas were selected for habitat improvements. Forty-two sites (coves and associated points) have been designated for habitat improvements on Lake Havasu, totalling approximately 875 acres. In addition, three major access sites are currently planned for development. Fish habitat enhancement identified in the program is scheduled to begin in 1992 and continue for five to ten years. Trail, dock and other construction will occur as the program develops. The designs and plans for each element of this program are conceptual and will probably change as the program evolves.

Prior to the implementation of the Lake Havasu Fisheries Improvement Program, federal and state agencies must comply with the various state and federal environmental laws. These laws include, but are not limited to, the National Environmental Policy Act, the Endangered Species Act, and the Clean Water Act. In addition, all fisheries improvement programs must be in compliance with Resource Management Plans, Habitat Management Plans, and other appropriate agency planning documents.

Pre-implementation inventories will be conducted at each site by AGFD and CDFG to provide baseline fishery data necessary for monitoring and evaluating the fisheries population response to habitat enhancement. A long-term habitat and angler improvement monitoring and evaluation plan will be prepared upon implementation of the program.

Following are brief descriptions of program elements proposed for the development and improvement of Lake Havasu fisheries and angling: artificial habitats, spawning cavities, shoreline angler access trails, and floating fishing docks.

### ARTIFICIAL FISH HABITATS

Fish hiding and rearing cover in Lake Havasu is almost non-existent. This Fisheries Improvement Program basically deals with areas having rooted aquatic vegetation, down to the approximate depth where the water temperature changes (20-25 feet).

Many things are used to enhance fish habitat. In lakes and reservoirs, artificial habitats are usually constructed from automobile tires, hardwood or softwood trees, and brush bundles. Many fish species show an affinity for floating or overhanging objects such as docks or breakwaters. Mid-water habitat structures have been successful in attracting fish in freshwater environments (Reeves et al. 1977). Several types of habitats create additional spawning areas; e.g., placement of cobble/boulder beds, suspended boxes of gravel that rise and fall with water fluctuations, bundles of PVC tubes with one end plugged, etc. Because some habitat, such as brush and trees, are relatively short-lived when submerged, alternative habitats constructed from modern plastics have been developed.

Artificial brush bundles, designed for bass shelters, are constructed from perforated plastic snow fencing material. A cluster of 21 modules is weighted with concrete blocks and submerged at selected locations. Other configurations may also be constructed to provide escape cover for larger fish such as spawning bass. A total of 67,482 bass shelter units of 21 modules each are planned for the 42 enhancement sites.

Catfish houses, feature artificial habitat simulating a darkened cavity (preferred catfish spawning sites). Six pieces of plastic pipe are strapped together, with one end of each pipe piece plugged with concrete. The structures are placed at depths of 10 to 12 feet along shorelines. Using two spacings of 10 and 15 feet, 54,724 units will be added to the designated coves.

An artificial tree, commercially referred to as a Fish 'N Forest, is a plastic stalk of three-foot pieces with two leaves (four petals) attached at each one-foot increment. Stalks are modular and snap together into various lengths. Average height of the stalks will be 15 feet. A weighted five- by ten-foot PVC pipe frame with seven trees attached forms one unit. The trees may also be individually anchored to the bottom using various types of weights and anchors. The stalks float vertically in the water, similar to natural kelp. For this project, 3,484 units constructed from 24,388 15-foot stalks are planned for placement at four sites. The Fish 'N Forests will physically occupy one percent of the surface area (871 five- by ten-foot units per surface acre).

At seven sites, tire towers will be placed as striped bass attractors. Each tower is a vertical pile of used tires (approximately 20 tires per tower), stacked over a weighted array of three rebars. Fifteen units, each with 10 towers, will be placed at each site for a total of 150 towers per site.

In addition to the synthetic attractors, 11,800 natural brush piles or bundles are proposed for this program. Whole Christmas, citrus, or mesquite trees, or brush bundles, either singly or in groups, will be strategically anchored at eight sites.

In summary, all of the artificial habitat structures will occupy about 10 percent of the aerial coverage of proposed enhancement zones (875 acres). Considering height and aerial coverage, nearly 90 acres of surface area in artificial fish structures will be installed in the 42 coves and associated points. In addition to their primary function, these structures will provide significant additional area for algae attachment. The following paragraphs describe the specific habitat structures and numbers of each to be used in Lake Havasu.

### 67,482 Bass Shelters

Purpose: Bass shelters provide escape and hiding cover for small fish by simulating conditions in natural brush piles.

Description: The basic module is a 16 inch diameter plastic snow fence tube on end, four feet tall with a plastic cone-shaped "hat" covering the top. Modules are clustered in groups of 21, fastened together with plastic fasteners. Each cluster is weighted with cinder blocks. The module weighs approximately 35 pounds.

Average Cost: $200 per structure (21-module unit)

### 54,724 Catfish Houses

Purpose: Catfish houses provide spawning cover for channel catfish. They serve as hiding cover for the fry and other small fish.

Description: A catfish house consists of six three-foot long pieces of 8-inch diameter polyethylene corrugated perforated drainage pipe tied up into a pyramid. The bottom layer has three tubes, the middle has two tubes, and the top has one tube. The tubes are plugged in one end with about three inches of concrete. The concrete plug is held in place by the corrugations in the pipe. The open ends are staggered in the pyramid so three face out one way and three face out the other. The bundle is tied with long lasting plastic strapping material. The unit weighs about 60-65 pounds. Generally, these structures will be around the margins of the project coves in about 10 feet of water. With a three- to four-foot annual fluctuation, they will usually be in at least four to six feet of water during the spawning season.

Average Cost: $40 per structure (unit)

### 3,484 Bass Ambushing Cover Structures

Purpose: Structures are currently being manufactured and sold under U.S. patent by Plastics Research and Development Corporation. The commercial name for the structures is Fish 'N Tree or Fish 'N Forest. Fish 'N Trees provide security cover and ambush sites for the large fish. They are placed in areas where the threadfin shad tend to occur based upon past observations, or next to natural weedbeds, bass shelters, brush piles, drop-offs and ledges where smaller prey fish will be hanging out.

Description: A plastic Fish 'N Tree is a stalk of three-foot pieces with two leaves for each foot of length. They are modular and can be made any length. Stalks 15 feet long will be used for this project. Groupings of the Fish 'N Trees will be individually prescribed for each site. Two types of attachments will be used: 1) a weighted 5- by 10-foot frame with seven trees (stalks) attached, and 2) stalks that are independently fastened down. The stalks float up in the water like kelp. Fish 'N Forests will be strategically placed with other habitat structures to simulate the characteristic features of a natural area of aquatic vegetation.

Average Cost: $1,050 per unit (five- by ten-foot frame with seven trees)

### 1,050 Tire Towers

Purpose: Tire towers create additional habitat structure adjacent to deep water areas, particularly to attract striped bass.

Description: Used tires donated to the project will be placed in tower-like fashion adjacent to deep water habitats. Each tower is a vertical pile of tires (approximately 20 tires per tower), stacked over a weighted array of three rebars. Ten towers will be combined into one unit to serve as habitat structure. These structures will increase the number of "breaks" from vertical/flat/vertical that fish seem to prefer.

Average Cost: $100 per tower

### 11,800 Brush Bundles

Purpose: Brush bundles provide escape and hiding cover for small fish.

Description: A brush bundle is a whole Christmas, citrus, or mesquite tree, or a eight-by eight- by eight-foot bundle of limbs and trunks. Trees and brush will be obtained from available local sources at no cost. Trees and brush bundles will be anchored to the reservoir floor by cinder blocks wired to their trunks.

Average Cost: No charge (materials donated)

## SHORELINE ANGLER ACCESS TRAILS

Foot access around Lake Havasu's shoreline is extremely limited. Existing trails are rugged and hazardous. Many areas of the shoreline are reachable only by boat. Approximately seven miles of new, quality trail for shore-based anglers are proposed to access improved fish habitats. Three types of trails (paved, gravel, and footpath) are proposed for this program. Gravel or footpath trails will extend around the shoreline at Black Rock Cove, Windsor Beach Four, Take-off Point, and Bill Williams Bridge Coves. A gravel trail or metal stairs will be established to access Blue Dock Cove. At two major access sites, Contact Point and Central Arizona Project Peninsula, paved trails will be constructed in addition to gravel trails to facilitate access by physically-challenged anglers. If needed, a gravel parking area will be established at access points for each gravel trail site.

## FLOATING FISHING DOCKS

Fishing docks increase angling opportunity and success. One floating or fixed piling dock is planned for each of the following sites: Contact Point, Site Six, and the Central Arizona Project Peninsula. Vehicle access, parking areas, a modern fish cleaning station, and restrooms will also be constructed at each dock site. These docks and associated facilities will be designed to promote access for physically-challenged anglers. In addition, a dock (but no associated facilities) is planned for Blue Dock Cove.

## MARINA ACCESS SITES

Some access sites include already developed marinas. Cooperators in this Fisheries Improvement Program will work with marina management to maintain adequate launching facilities for boaters, and, when feasible, to provide fishing opportunities within marina bounds. Habitat structures may be placed within marina bounds if desired by marina management. Determinations for habitat improvements will be made as the program develops.

## SPECIAL EQUIPMENT

Because most coves identified in this program are not accessible by land, large, durable work boats will be necessary to transport habitat structures and program personnel to enhancement sites. The large scope and long duration of the Lake Havasu Fisheries Improvement Program necessitate that these boats be owned and maintained by the lead cooperating agency, not just borrowed, to ensure reliable and available transportation as the program develops. Two large pontoon boats will provide necessary loading and working space required by this program. One boat would be a 40-foot pontoon "barge," with a 13-foot wide deck, aluminum pontoons, and no motor (estimated cost: $15,000). The entire deck could be used as loading and work space for dumping the habitat structures into the water. The second boat would be a 30-foot pontoon boat, with a shade covering half the deck, and a 150-200 horsepower engine (estimated cost: $20,000). This boat would be used to pull the barge, transport personnel, and also provide some work space. Additional boats may be contracted from state or other federal agencies as specific projects are implemented.

Other necessary special equipment such as four-wheel drive vehicles, all-terrain vehicles (ATVs), generators, shelters, portable cement mixers, camping equipment, etc. are not included in this program. These items will be determined as planning progresses.

## IMPLEMENTATION

An environmental analysis of the Lake Havasu Fisheries Improvement Program will be completed prior to the initiation of the projects. Inter-disciplinary team members are composed of Bureau of Land Management and Bureau of Reclamation Specialists (engineering, recreation, fisheries, and wildlife), Arizona Game and Fish Department biologists, and California Department of Fish and Game biologists. Concurrent with this analysis will be project-specific planning efforts by an implementation team consisting of Bureau of Land Management and Bureau of Reclamation fish and wildlife biologists, state fisheries biologists, and the public represented by Anglers United.

Implementation of the Lake Havasu Fisheries Improvement Program will begin in spring 1992, emphasizing habitat enhancement for Arizona and California coves in the immediate area of Lake Havasu City, Arizona. Purchase of materials and implementation of habitat and access improvements for the remaining coves will be scheduled as the program develops.

## COSTS

Funding for proposed enhancement measures is anticipated from several sources: direct Bureau of Land Management dollars, State Lake Improvement Funds, Anglers United funds, other state and federal agency funds, corporate sponsors, and foundation grants. Challenge Cost-Share agreements with various sportsmens groups will be used to obtain donations of supplies, equipment, and labor. Various marketing schemes will be employed to attract sponsors. Donors will be encouraged to fund specific stages of cove development so they can identify their accomplishments. Large donors may even "adopt" a trail, dock, or an entire cove. Their contributions will be acknowledged by signs, plaques, interpretive displays, and printed material. The largest estimated costs for this program are for the artificial habitat materials. Table 1 outlines the number of structures and material costs for each habitat type for each planning segment on Lake Havasu.

**TABLE 1.** **Total number of structures and materials cost for each planning segment of the Lake Havasu Fisheries Improvement Program. Estimates are based on draft figures established as of November 22, 1991 and are rounded to the nearest thousand.**

| Segment | Bass Shelters Number | Bass Shelters Cost | Catfish Houses Number | Catfish Houses Cost | Fish 'N Forests Number | Fish 'N Forests Cost | Tire Towers Number | Tire Towers Cost | Brush Bundles No.[a] |
|---|---|---|---|---|---|---|---|---|---|
| Head of Lake | 27,180 | $ 5,436,000 | 19,026 | $ 761,000 | 871 | $ 915,000 | 150 | $ 15,000 | 0 |
| Pittsburgh Point | 12,627 | $ 2,525,000 | 15,979 | $ 639,000 | 871 | $ 915,000 | 450 | $ 45,000 | 0 |
| Steamboat Cove | 9,135 | $ 1,827,000 | 6,741 | $ 270,000 | 0 | -------- | 0 | -------- | 0 |
| Standard Wash | 8,640 | $ 1,728,000 | 6,048 | $ 242,000 | 871 | $ 915,000 | 0 | -------- | 0 |
| Gene Wash | 5,940 | $ 1,188,000 | 4,158 | $ 166,000 | 871 | $ 915,000 | 300 | $ 30,000 | 8,000 |
| Bill Williams River Arm | 3,960 | $ 792,000 | 2,772 | $ 111,000 | 0 | -------- | 150 | $ 15,000 | 4,000 |
| TOTAL | 67,482 | $13,496,000 | 54,724 | $2,189,000 | 3,484 | $3,660,000 | 1,050 | $105,000 | 12,000 |

[a] No charge for brush bundles. Materials will be donated by Metropolitan Water District.

**TABLE 2.** **Total number for habitat and angler access improvements in each planning segment of the Lake Havasu Fisheries Improvement Program. Estimates are based on draft figures established as of November 22, 1991 and are rounded to the nearest thousand.**

| Segment | Habitat Structures[a] | Basic Workforce[b] | Access Improvements[c] | Engineering and Contracting[d] | Total Cost for Segment |
|---|---|---|---|---|---|
| Head of Lake | $ 7,127,000 | $ 2,125,000 | $ 0 | $ 0 | $ 9,252,000 |
| Pittsburgh Point | $ 4,124,000 | $ 1,329,000 | $ 1,170,000 | $ 176,000 | $ 6,799,000 |
| Steamboat Cove | $ 2,097,000 | $ 714,000 | $ 0 | $ 0 | $ 2,811,000 |
| Standard Wash | $ 2,885,000 | $ 700,000 | $ 0 | $ 0 | $ 3,585,000 |
| Gene Wash | $ 2,299,000 | $ 454,000 | $ 0 | $ 0 | $ 2,753,000 |
| Bill Williams River Arm | $ 918,000 | $ 296,000 | $ 758,000 | $ 114,000 | $ 2,086,000 |
| **TOTAL** | **$ 19,450,000** | **$ 5,618,000** | **$ 1,928,000** | **$ 290,000** | **$ 27,286,000[e]** |

[a] Habitat Structures include Bass Shelters, Catfish Houses, Fish 'N Forests, Tire Towers, and Brush Bundles. See text for further description.

[b] Basic Workforce (labor) wages estimated at $15.00 per hour.

[c] Access Improvements include docks, trails (gravel and paved), parking areas, restrooms, and fish cleaning stations. See text for further description.

[d] Engineering and contracting costs estimated at 15% of Access Improvements costs.

[e] This total does not include $35,000 special equipment cost.

Estimated direct costs for each planning segment range from $2,086,000 to $9,252,000, totalling $27,286,000 (Table 2). Estimated direct costs identified for the entire program are:

| | |
|---|---|
| Artificial Habitat Materials | $ 19,450,000 |
| Access Improvements | $ 1,928,000 |
| Basic Workforce | $ 5,618,000 |
| Engineering Design and Contracting | $ 290,000 |
| Special Equipment | $ 35,000 |
| TOTAL COST FOR PROGRAM | $ 27,320,000 |

## EVALUATION

Habitat and population monitoring is the responsibility of the U.S. Bureau of Land Management, Arizona Game and Fish Department, and California Department of Fish and Game. Pre-project implementation surveys will be conducted by the state wildlife agencies (AGFD, CDFG) to provide baseline data. Post-implementation monitoring of fish habitat and angler improvements will occur on an annual basis. Monitoring results will guide future enhancement activities within the lower Colorado River system (e.g. backwaters, river channel, etc.).

## BENEFITS

Implementation of this program will provide many benefits. Achieving the goals of the program will increase numbers of warmwater game fish which in turn will improve angling success. Access to the improved fishery will be enhanced for the non-boating public. Improved access will enable the public to get to habitat improvements safely and utilize them in greater comfort.

Local economies also will benefit from implementation of this program. Similar projects along smaller lakes in Arizona indicate there is a substantial increase of Angler Use Days. At Saguaro Lake, six miles of access trails were constructed. The U.S. Forest Service estimates they will increase angler use by 6,000 Angler Use Days per year. This program proposes seven miles of trails, not all in one place, which is the case at Saguaro Lake. A conservative estimate is the trails will increase angler use days at Lake Havasu by 10,000 per year.

A dock built at Canyon Lake, similar to the four proposed in this plan, is receiving 15,000 angler use days per year. Multiply this by four and you have a potential total use of 60,000 days per year.

Approximately 36,550 Angler Use Days are spent by anglers in boats. As the fishing improves and word spreads, this use will probably increase by at least 50 percent. This would result in an increase of slightly more than 18,000 angler use days.

The U.S. Fish and Wildlife Service estimates an Angler Use Day is worth $39.74. With this potential increase of more than 88,000 Angler Use Days, approximately $3.5 million per year could be returned to the local economy.

## ACKNOWLEDGMENTS

This program's development is responsible, in large part, to numerous federal, state, and private entities involved in fisheries conservation, recreation, and enhancement. Special acknowledgment goes to the cooperative efforts of the following agencies and organization:

U.S.D.I. Bureau of Land Management
Arizona Game and Fish Department
California Department of Fish and Game
U.S.D.I. Bureau of Reclamation
Anglers United

In addition, appreciation is extended to the following groups for their contributions and efforts:

U.S.D.I. Fish and Wildlife Service
Havasu National Wildlife Refuge
Arizona State Parks Department
Lake Havasu City Parks and Recreation Department
Local and Statewide Bass Angler and Sportsmen's Societies

## PERSONNEL

The following list identifies key project personnel and their affiliation:

Mike Henderson, Resource Area Wildlife Management Biologist
U.S.D.I. Bureau of Land Management, Havasu Resource Area
3189 Sweetwater Avenue, Lake Havasu City, AZ 86403
Phone: (602) 855-8017

Dave LaMorte, President, Anglers United
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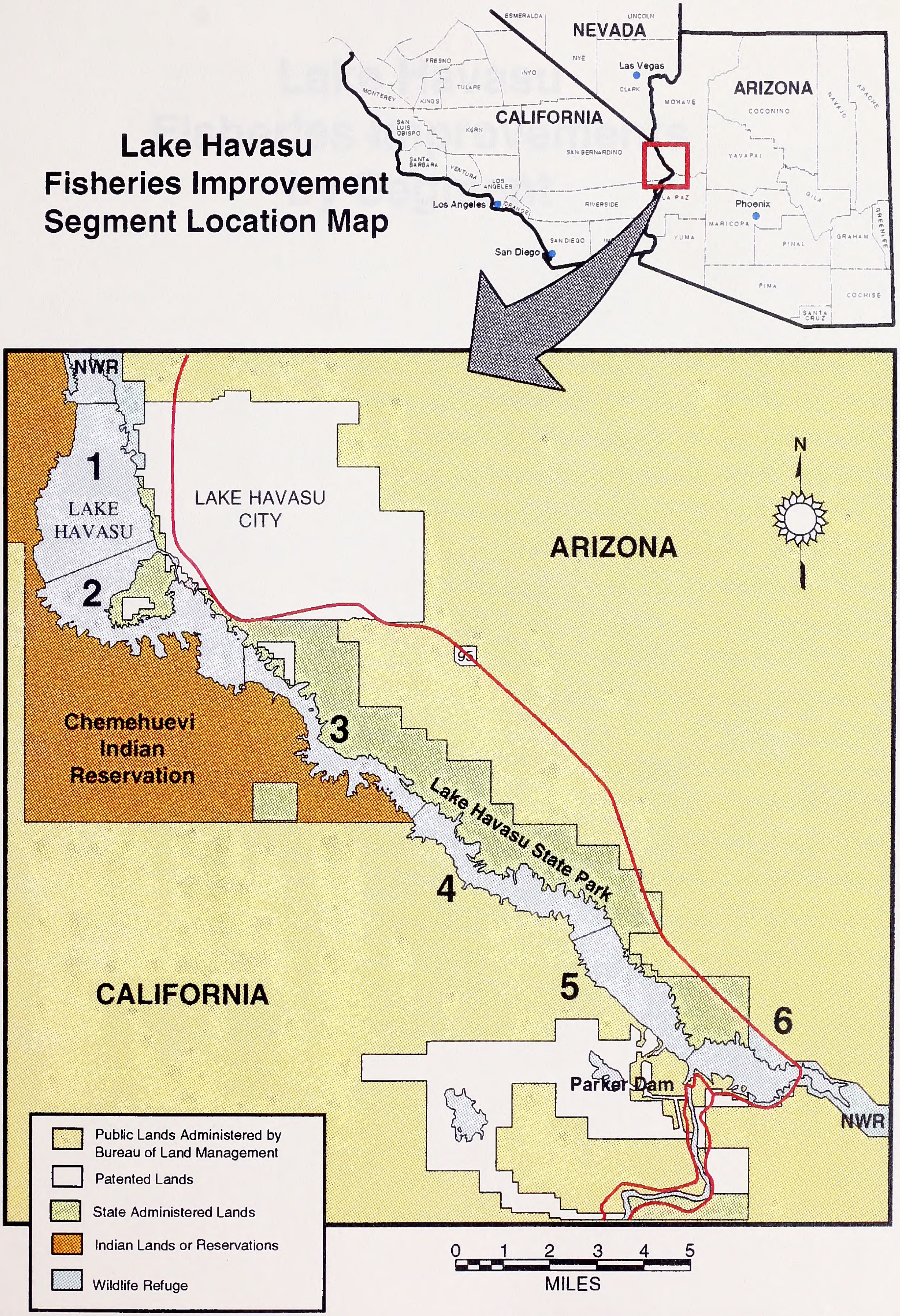
Ron Powell, Associate Wildlife-Manager Biologist,
Colorado River Coordinator
California Department of Fish and Game
P.O. Box BD, Blythe, CA 92226
Phone: (619) 922-6508

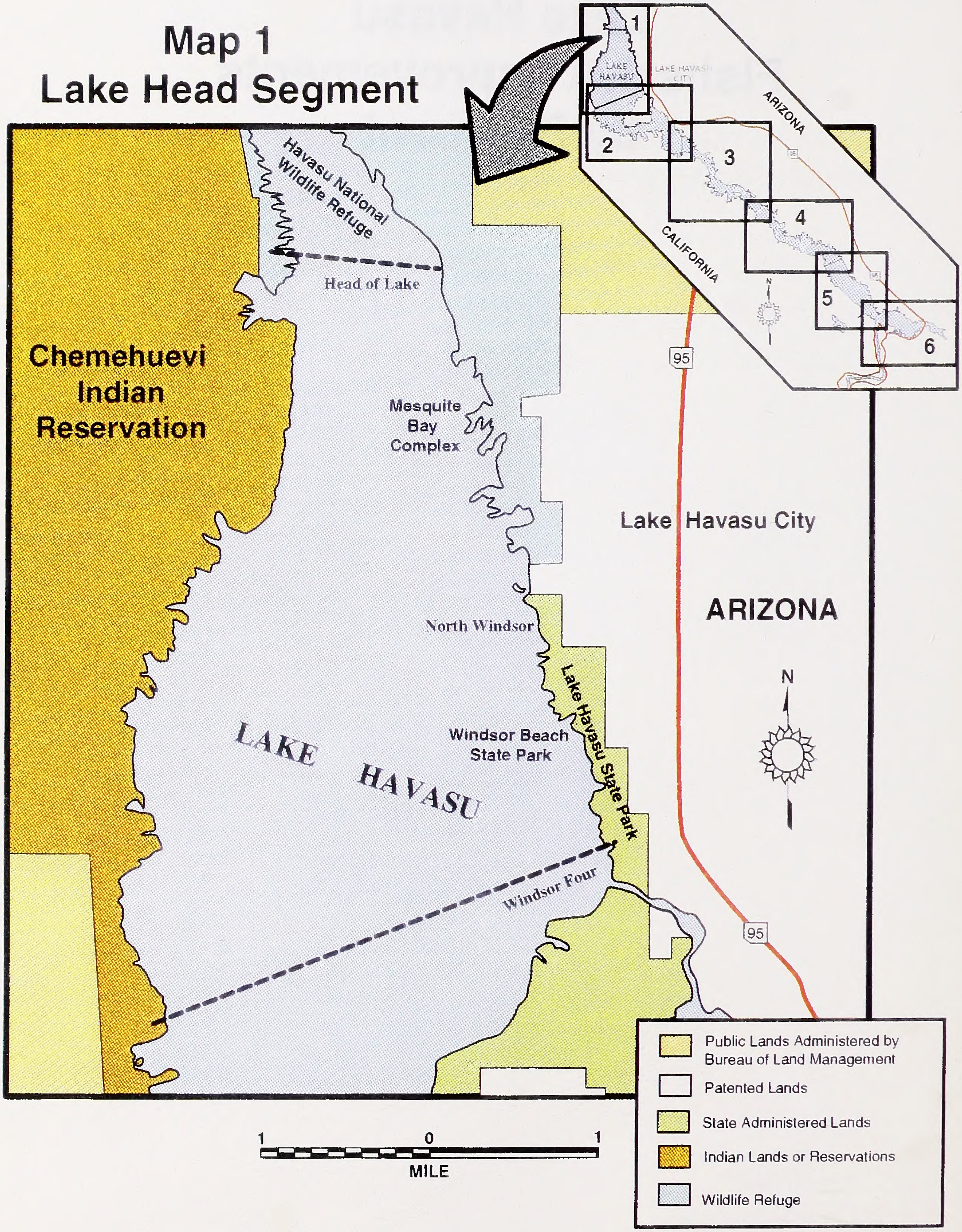
Tom Burke, Fishery Biologist
Bureau of Reclamation
Lower Colorado River Regional Office
P.O. Box 61470, Boulder City, NV 89006-1470
Phone: (702) 293-8711

# Lake Havasu Fisheries Improvement Segment Location Map



# Lake Havasu Fisheries Improvements by Segment

# Map 1
## Lake Head Segment



# LAKE HEAD SEGMENT

Acres of Improvement: 303
Estimated Hours of Labor: 141,681
Total Estimated Cost: $9,251,805

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 27,180 | Bass Shelters | $5,436,000 |
| 19,026 | Catfish Houses | $ 761,040 |
| 871 | Fish 'N Forests | $ 914,550 |
| 150 | Tire Towers | $ 15,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $2,125,215 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

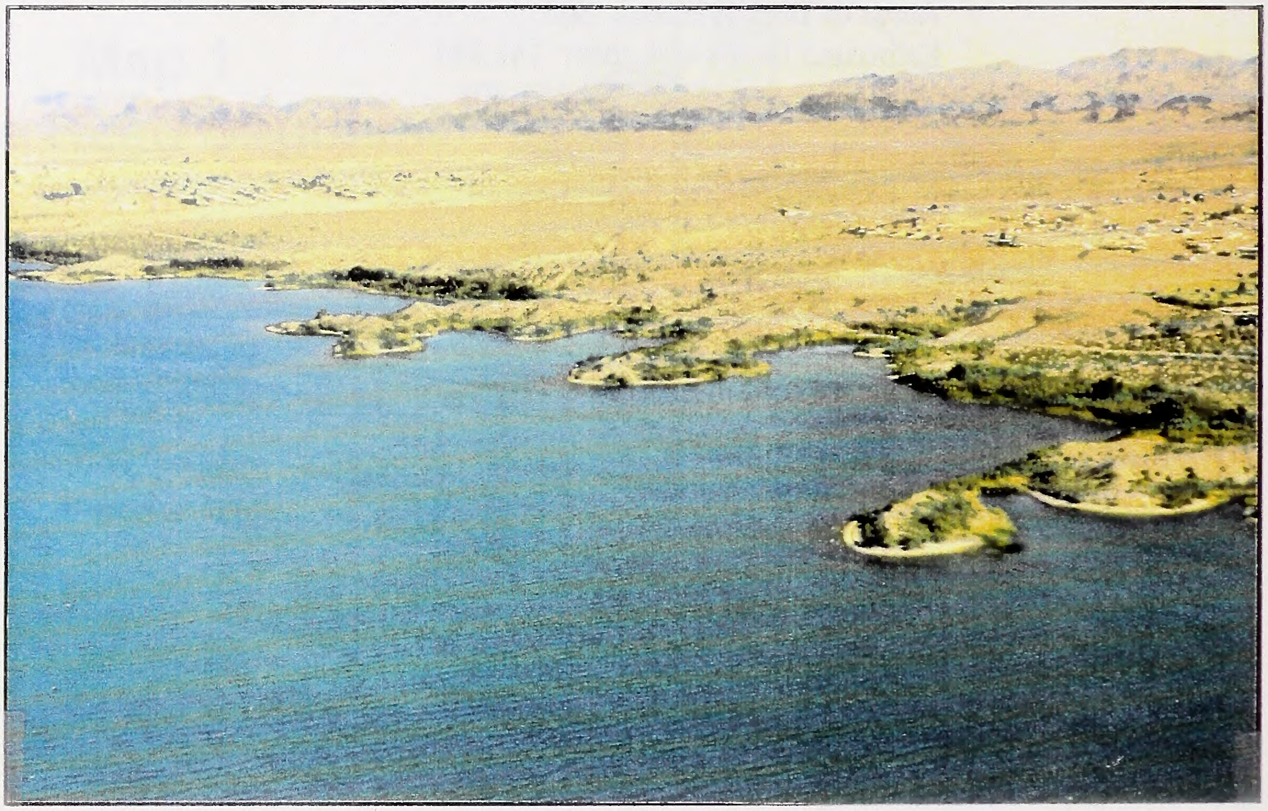
## EQUIPMENT

Necessary equipment such as pontoon boats, 4-WD vehicles, ATVs, generators, shelters, portable cement mixers, camping equipment, etc. are not included. These items are to be determined as planning progresses.

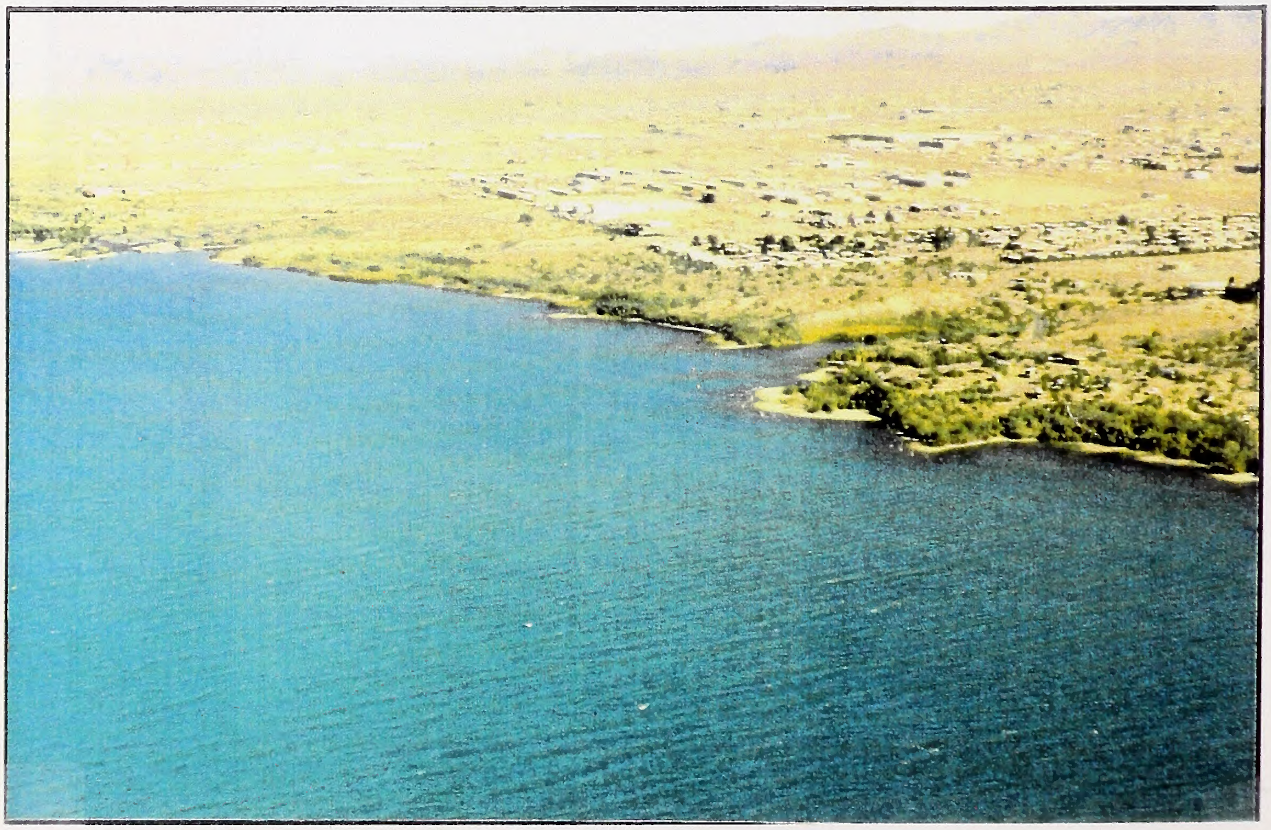
## VOLUNTEERS AND FINANCIAL SPONSORS

Funds and responsible organizations to do the work are being sought by Anglers United. Contact: Dave LaMorte - (602) 839-0660 or Mike Henderson - (602) 855-8017.

## LAKE HEAD SEGMENT

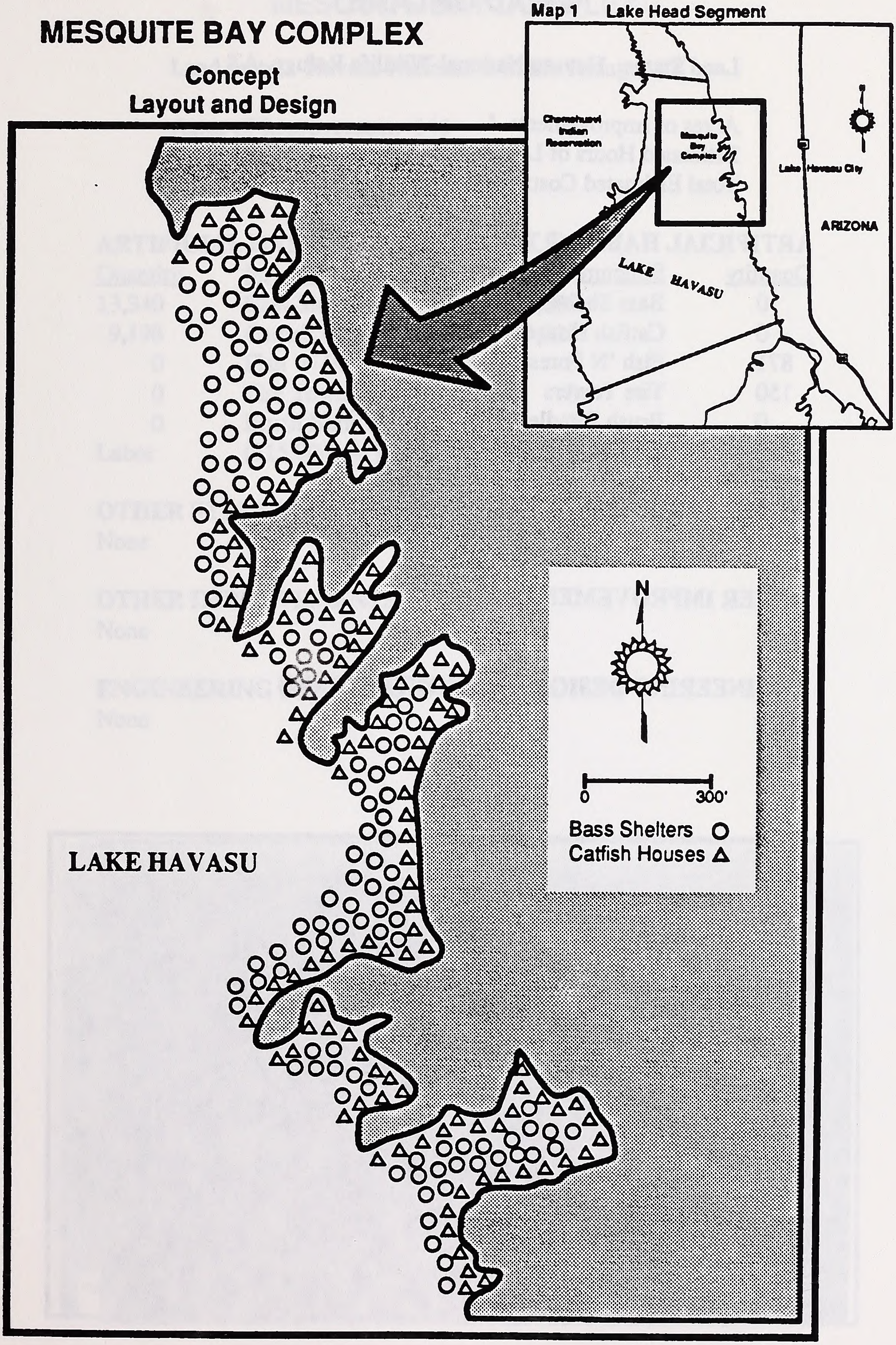


Mesquite Bay Complex, Arizona



Windsor Beach State Park, Arizona

# MESQUITE BAY COMPLEX
## Concept
## Layout and Design



# HEAD OF LAKE

Land Status: Havasu National Wildlife Refuge, AZ

Acres of Improvement: 1
Estimated Hours of Labor: 3,063
Total Estimated Cost: $975,495

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 0 | Bass Shelters | $ 0 |
| 0 | Catfish Houses | $ 0 |
| 871 | Fish 'N Forests | $914,550 |
| 150 | Tire Towers | $ 15,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 45,945 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

# MESQUITE BAY COMPLEX

Land Status: Havasu National Wildlife Refuge, AZ

Acres of Improvement: 146
Estimated Hours of Labor: 67,014
Total Estimated Cost: $4,001,130

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 13,340 | Bass Shelters | $2,628,000 |
| 9,198 | Catfish Houses | $ 367,920 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $1,005,210 |

## OTHER STRUCTURES

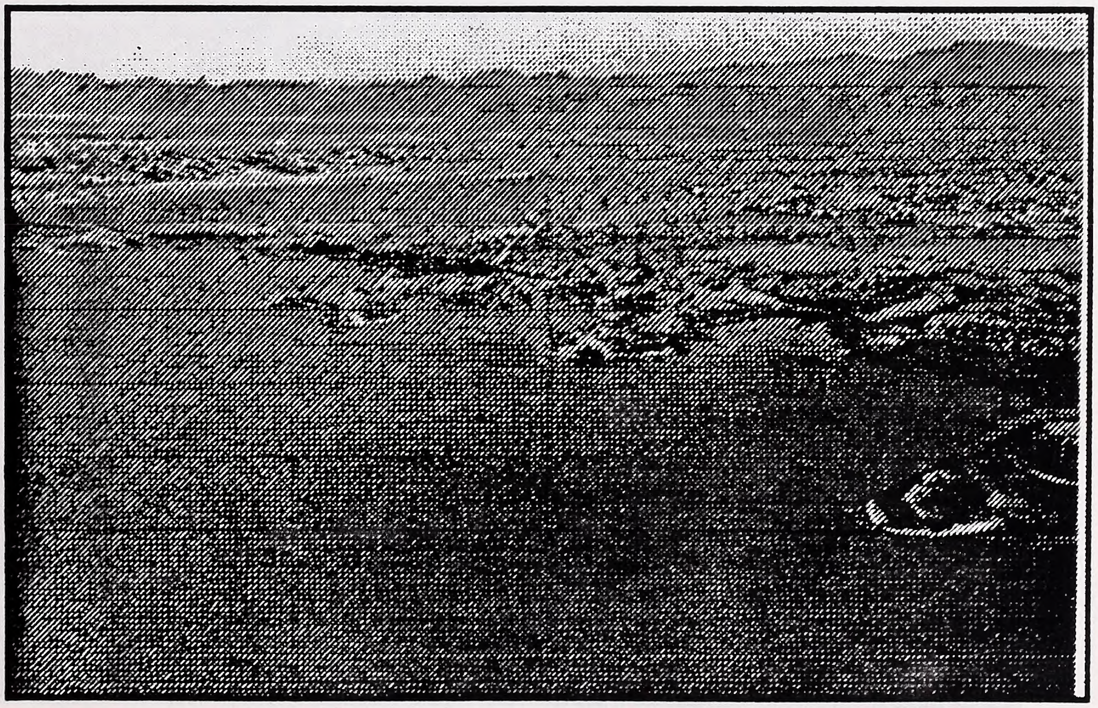
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# NORTH WINDSOR

Land Status: Arizona State Parks, AZ

Acres of Improvement: 73
Estimated Hours of Labor: 33,507
Total Estimated Cost: $2,000,565

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 6,570 | Bass Shelters | $1,314,000 |
| 4,599 | Catfish Houses | $ 183,960 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 502,605 |

## OTHER STRUCTURES

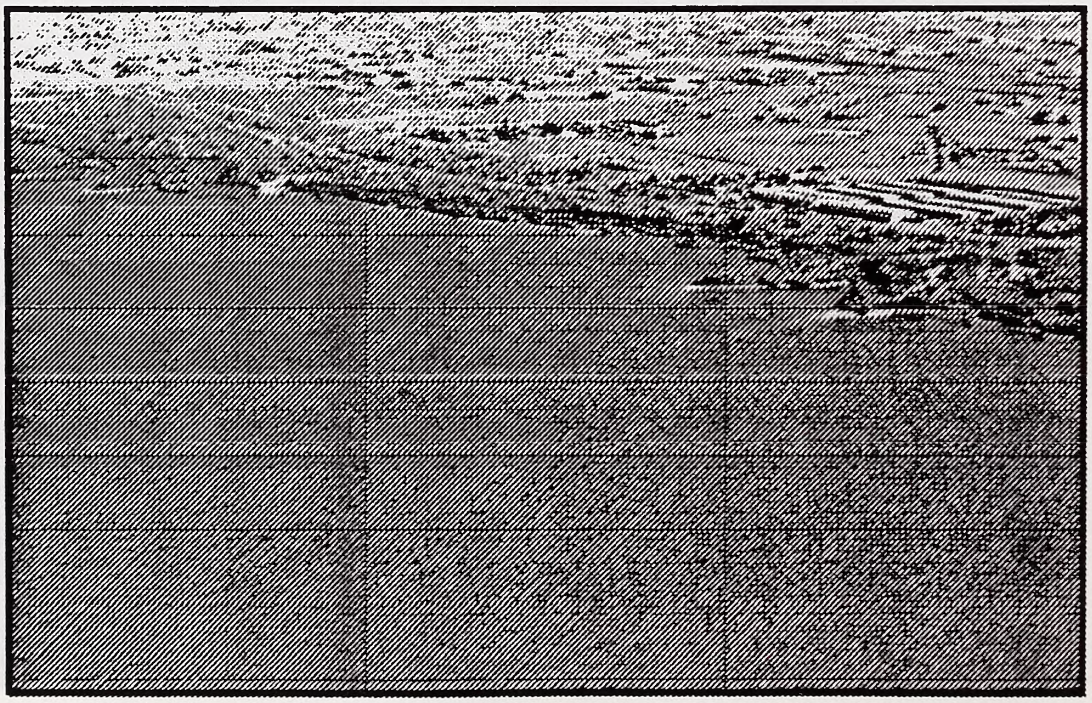
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# WINDSOR BEACH STATE PARK

Land Status: Arizona State Parks, AZ

Acres of Improvement: 83
Estimated Hours of Labor: 38,097
Total Estimated Cost: $2,274,615

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 7,470 | Bass Shelters | $1,494,000 |
| 5,229 | Catfish Houses | $ 209,160 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 571,455 |

## OTHER STRUCTURES

None

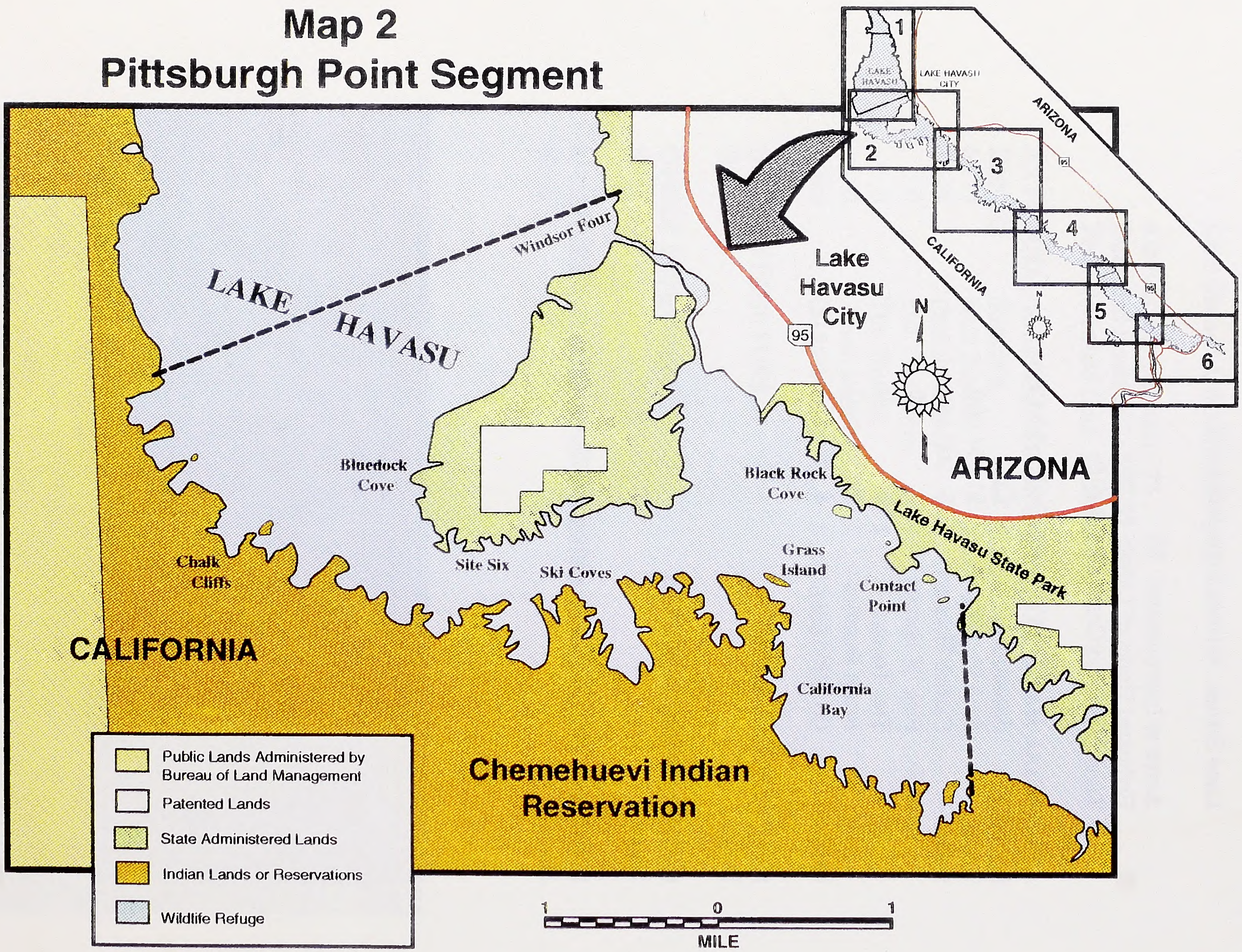
## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

# Map 2
## Pittsburgh Point Segment



# PITTSBURGH POINT SEGMENT

Acres of Improvement: 255.5
Estimated Hours of Labor: 88,611
Total Estimated Cost: $6,798,775

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 12,627 | Bass Shelters | $2,525,400 |
| 15,979 | Catfish Houses | $ 639,160 |
| 871 | Fish 'N Forests | $ 914,550 |
| 450 | Tire Towers | $ 45,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $1,329,165 |

## OTHER STRUCTURES

| | | |
|---|---|---|
| 3 | Docks | $ 700,000 |
| 1 | Underwater Viewing Area | $ 100,000 |
| 1 | Breakwater | $ 30,000 |

## OTHER IMPROVEMENTS

Trails (2.8 miles)
1 Parking Lot
2 Fish Cleaning Stations $ 60,000

## ENGINEERING DESIGN AND CONTRACTING

$ 175,500

## EQUIPMENT

Necessary equipment such as pontoon boats, 4-WD vehicles, ATVs, generators, shelters, portable cement mixers, camping equipment, etc. are not included. These items are to be determined as planning progresses.

## VOLUNTEERS AND FINANCIAL SPONSORS

Funds and responsible organizations to do the work are being sought by Anglers United. Contact: Dave LaMorte - (602) 839-0660 or Mike Henderson - (602) 855-8017.

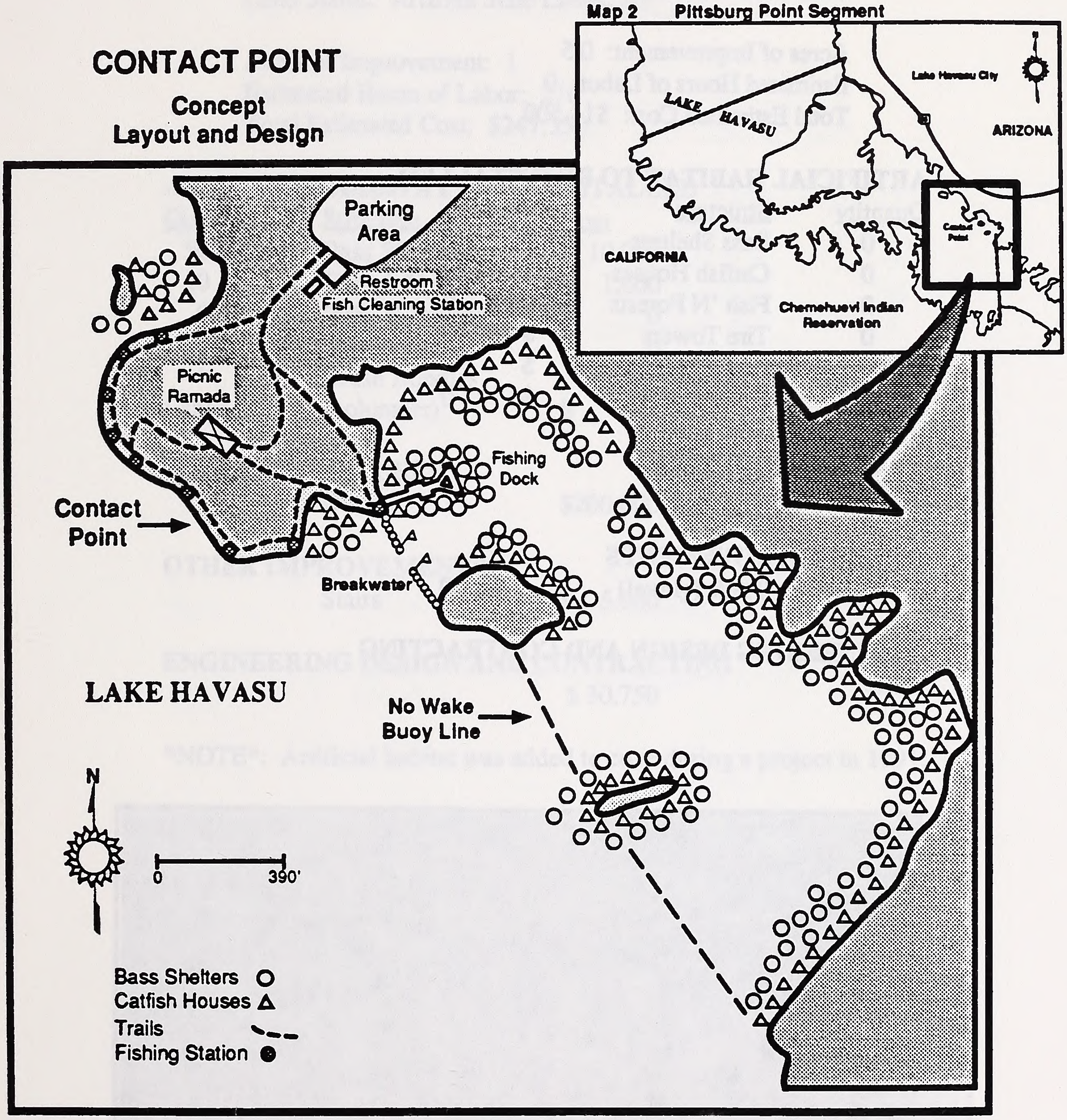
# PITTSBURGH POINT SEGMENT

Blue Dock Cove, Arizona

Contact Point, Arizona

## CONTACT POINT

### Concept Layout and Design



# WINDSOR BEACH FOUR

Land Status: Arizona State Parks, AZ

Acres of Improvement: 0.5
Estimated Hours of Labor: 0
Total Estimated Cost: $11,500

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 0 | Bass Shelters | $ 0 |
| 0 | Catfish Houses | $ 0 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 0 |

## OTHER STRUCTURES

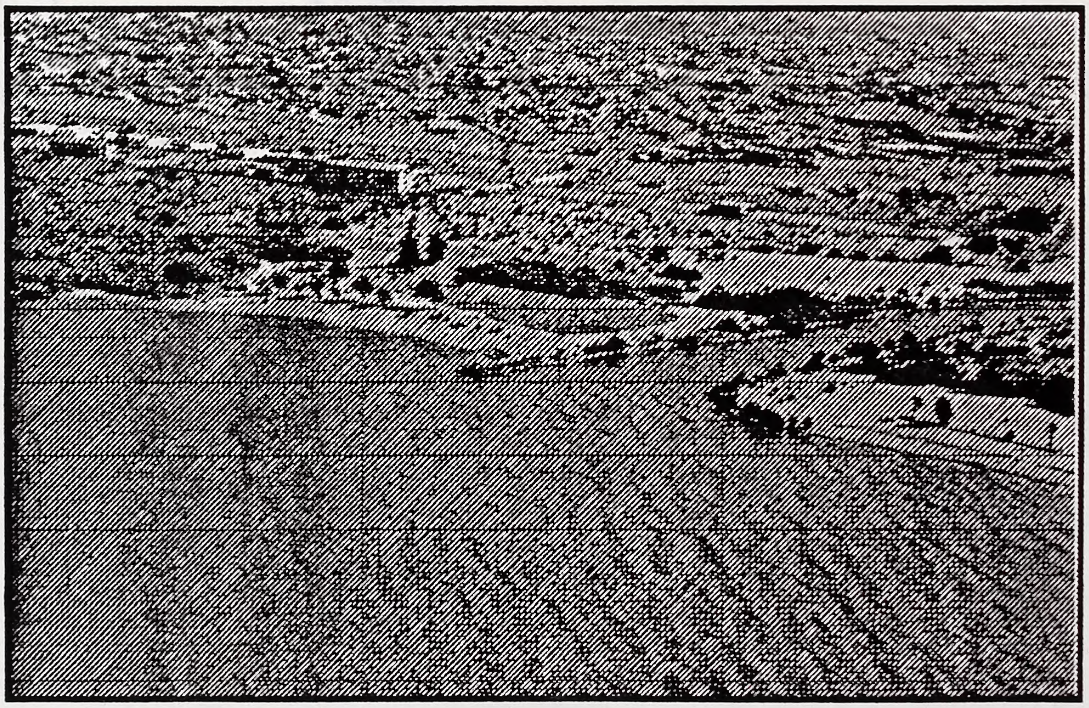
None

## OTHER IMPROVEMENTS

| | |
|---|---|
| Trails (gravel) | $10,000 |

## ENGINEERING DESIGN AND CONTRACTING

None



# BLUE DOCK COVE

Land Status: Arizona State Lands, AZ

Acres of Improvement: 1
Estimated Hours of Labor: 270
Total Estimated Cost: $247,350

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 50 | Bass Shelters | $ 10,000 |
| 40 | Catfish Houses | $ 1,600 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| * | Brush Bundles | * |
| Labor | (volunteer) | $ 0 |

## OTHER STRUCTURES

| | | |
|---|---|---|
| 1 | Dock | $200,000 |

## OTHER IMPROVEMENTS

| | | |
|---|---|---|
| | Stairs | $ 5,000 |

## ENGINEERING DESIGN AND CONTRACTING

$ 30,750

*NOTE*: Artificial habitat was added to cove during a project in 1991.

# SITE SIX

Land Status: Lake Havasu City, AZ

Acres of Improvement: 3
Estimated Hours of Labor: 1,287
Total Estimated Cost: $358,865

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 90 | Bass Shelters | $ 18,000 |
| 189 | Catfish Houses | $ 7,560 |
| 0 | Fish 'N Forests | $ 0 |
| 150 | Tire Towers | $ 15,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 19,305 |

## OTHER STRUCTURES

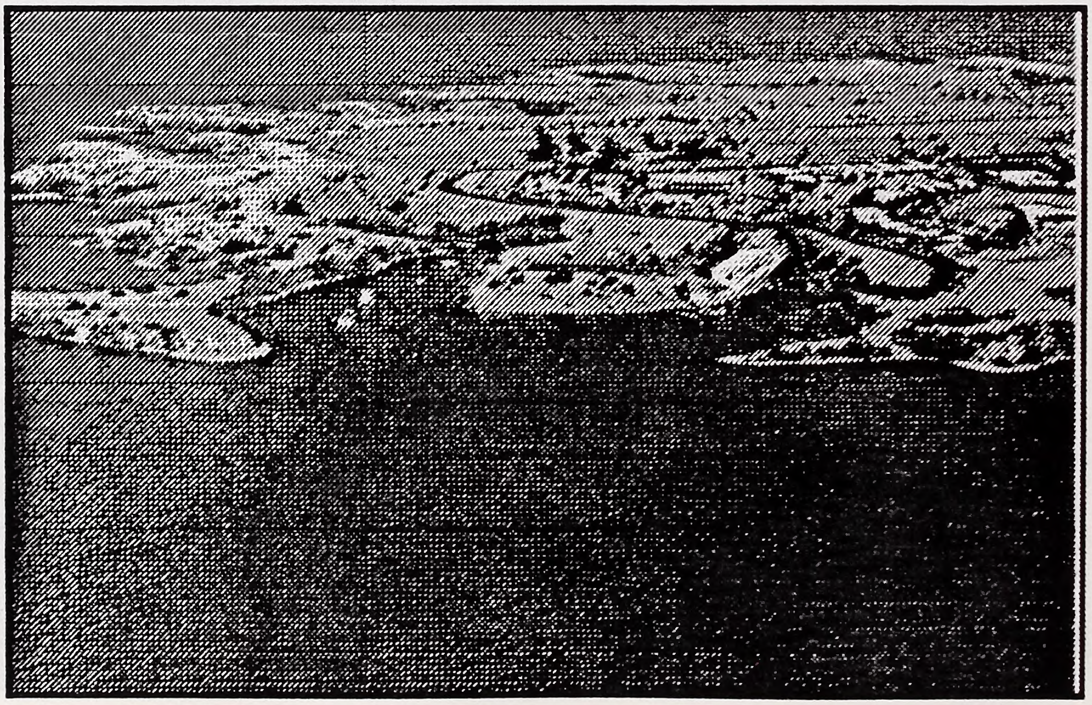
| | | |
|---|---|---|
| 1 | Dock | $200,000 |

## OTHER IMPROVEMENTS

| | | |
|---|---|---|
| 1 | Fish Cleaning Stations | $ 60,000 |

## ENGINEERING DESIGN AND CONTRACTING

$ 39,000



## CHALK CLIFFS

Land Status: Chemeheuvi Indian Reservation, CA

Acres of Improvement: 45
Estimated Hours of Labor: 23,268
Total Estimated Cost: $2,186,970

### ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 4,050 | Bass Shelters | $810,000 |
| 2,835 | Catfish Houses | $113,400 |
| 871 | Fish 'N Forests | $914,550 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $349,020 |

### OTHER STRUCTURES

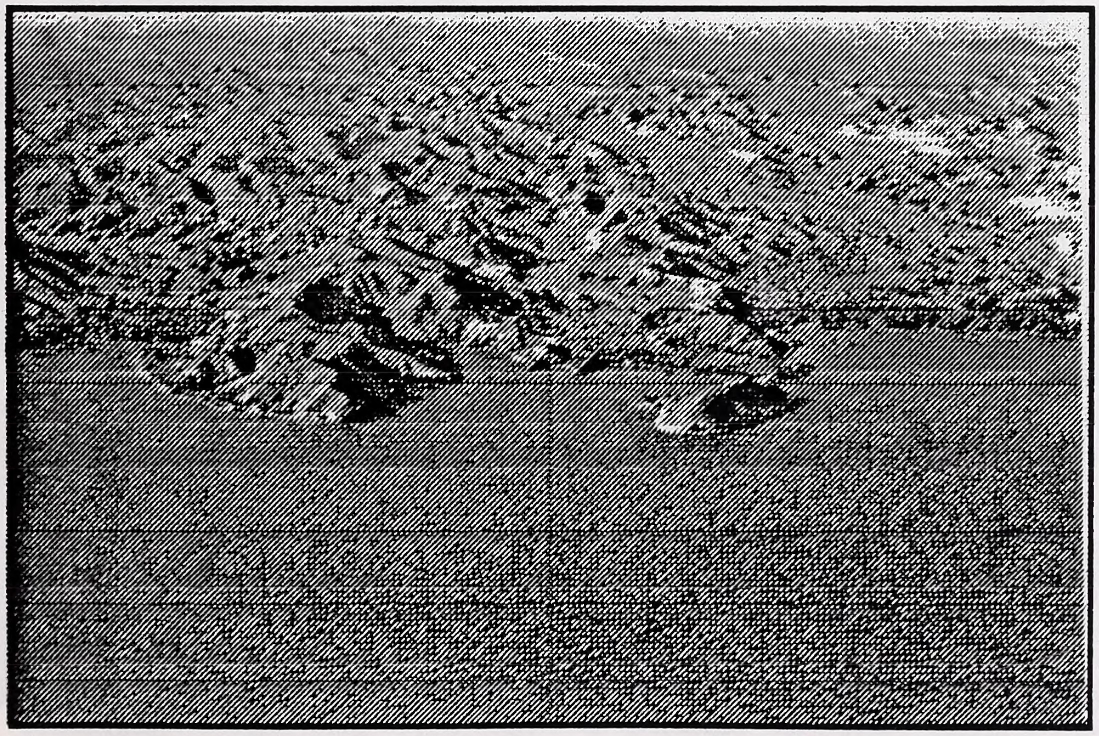
None

### OTHER IMPROVEMENTS

None

### ENGINEERING DESIGN AND CONTRACTING

None



# SKI COVES

Land Status: Chemeheuvi Indian Reservation, CA

Acres of Improvement: 97
Estimated Hours of Labor: 18,333
Total Estimated Cost: $519,435

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 0 | Bass Shelters | $ 0 |
| 6,111 | Catfish Houses | $244,440 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $274,995 |

## OTHER STRUCTURES

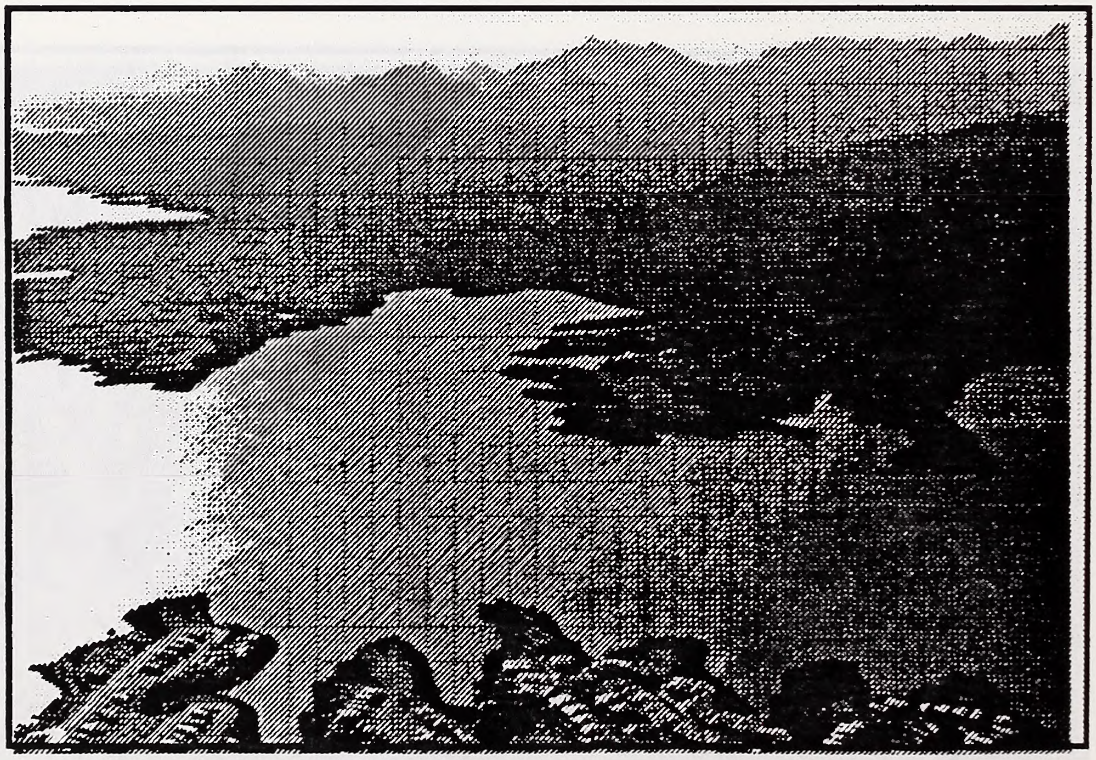
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



## BLACK ROCK COVE

Land Status: Arizona State Lands, AZ

Acres of Improvement: 19
Estimated Hours of Labor: 4,872
Total Estimated Cost: $267,540

### ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 427 | Bass Shelters | $85,400 |
| 1,197 | Catfish Housesf | $47,880 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| * | Brush Bundles | * |
| Labor | ($15.00/hour) | $73,080 |

### OTHER STRUCTURES

None

### OTHER IMPROVEMENTS

| | | |
|---|---|---|
| | Trails (footpath) | |
| | Parking | $53,200 |

### ENGINEERING DESIGN AND CONTRACTING

$ 7,980

*NOTE*: Brush structures were added to the cove during a previous project.

# CONTACT POINT

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 40
Estimated Hours of Labor: 18,360
Total Estimated Cost: $1,849,270

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 3,600 | Bass Shelters | $720,000 |
| 2,520 | Catfish Houses | $100,800 |
| 0 | Fish 'N Forests | $ 0 |
| 150 | Tire Towers | $ 15,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $275,400 |

## OTHER STRUCTURES

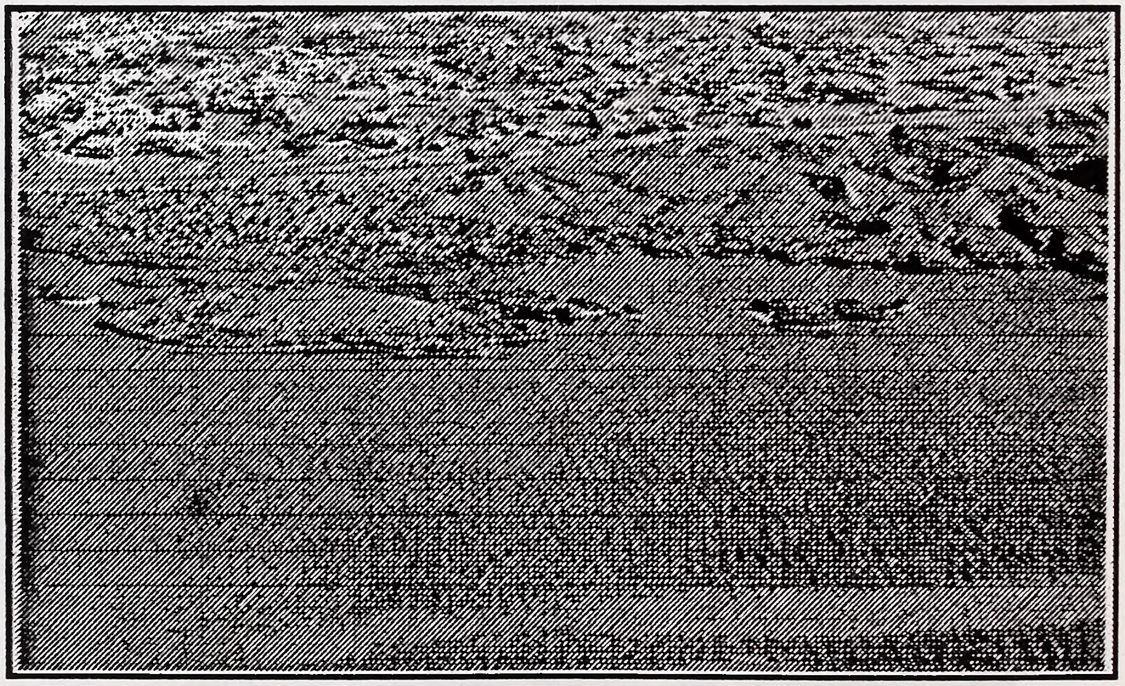
| | | |
|---|---|---|
| 1 | Dock | $300,000 |
| 1 | Underwater Viewing Area | $100,000 |
| 1 | Breakwater | $ 30,000 |

## OTHER IMPROVEMENTS

| | | |
|---|---|---|
| | Trails (paved and gravel) | |
| 1 | Cleaning Station | $211,800 |

## ENGINEERING DESIGN AND CONTRACTING

$ 96,270



# CALIFORNIA BAY

Land Status: Chemeheuvi Indian Reservation, CA

Acres of Improvement: 49
Estimated Hours of Labor: 22,491
Total Estimated Cost: $1,230,390

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 4,410 | Bass Shelters | $882,000 |
| 3,087 | Catfish Houses | $123,480 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $337,365 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

# GRASS ISLAND

Land Status: Chemeheuvi Indian Reservation, CA

Acres of Improvement: 1
Estimated Hours of Labor: 450
Total Estimated Cost: $15,000

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 0 | Bass Shelters | $ 0 |
| 0 | Catfish Houses | $ 0 |
| 0 | Fish 'N Forests | $ 0 |
| 150 | Tire Towers | $15,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | (volunteer) | $ 0 |

## OTHER STRUCTURES

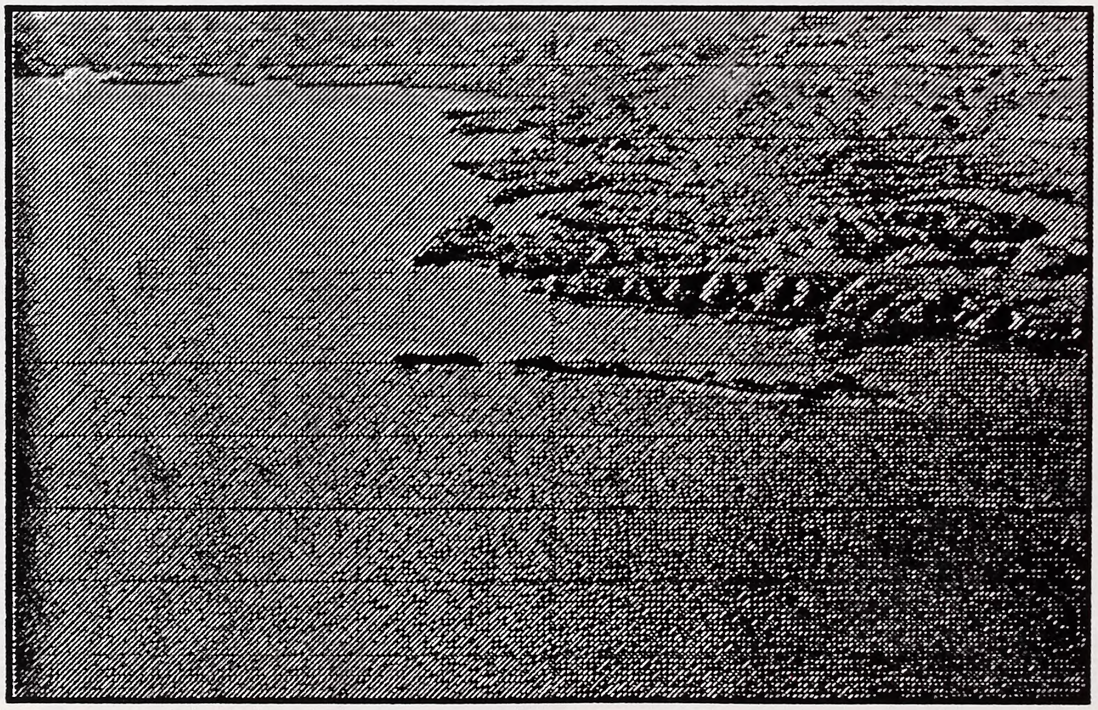
None

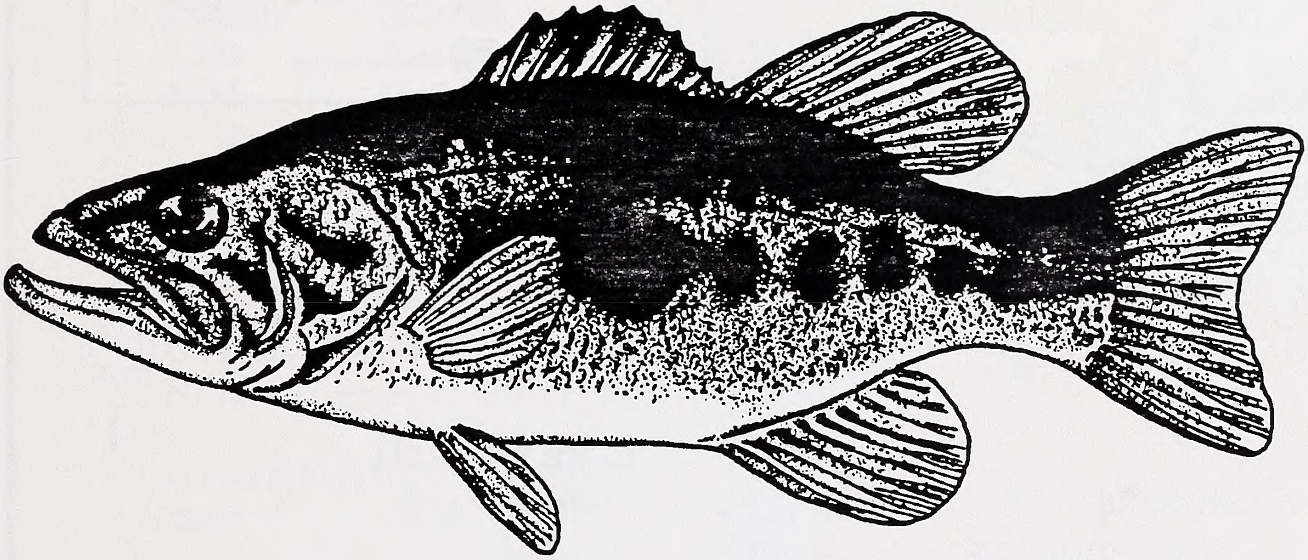
## OTHER IMPROVEMENTS

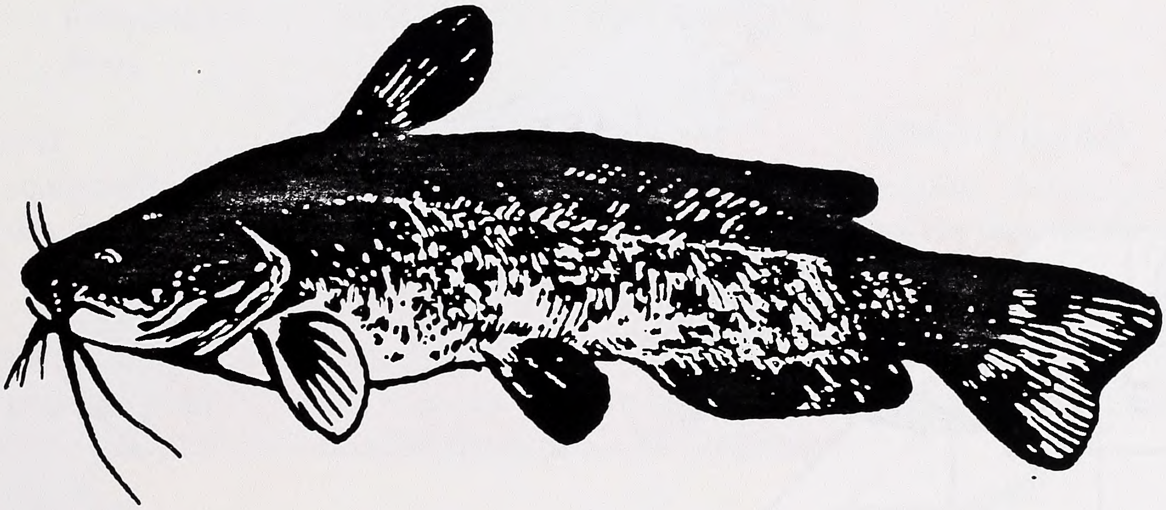
None

## ENGINEERING DESIGN AND CONTRACTING

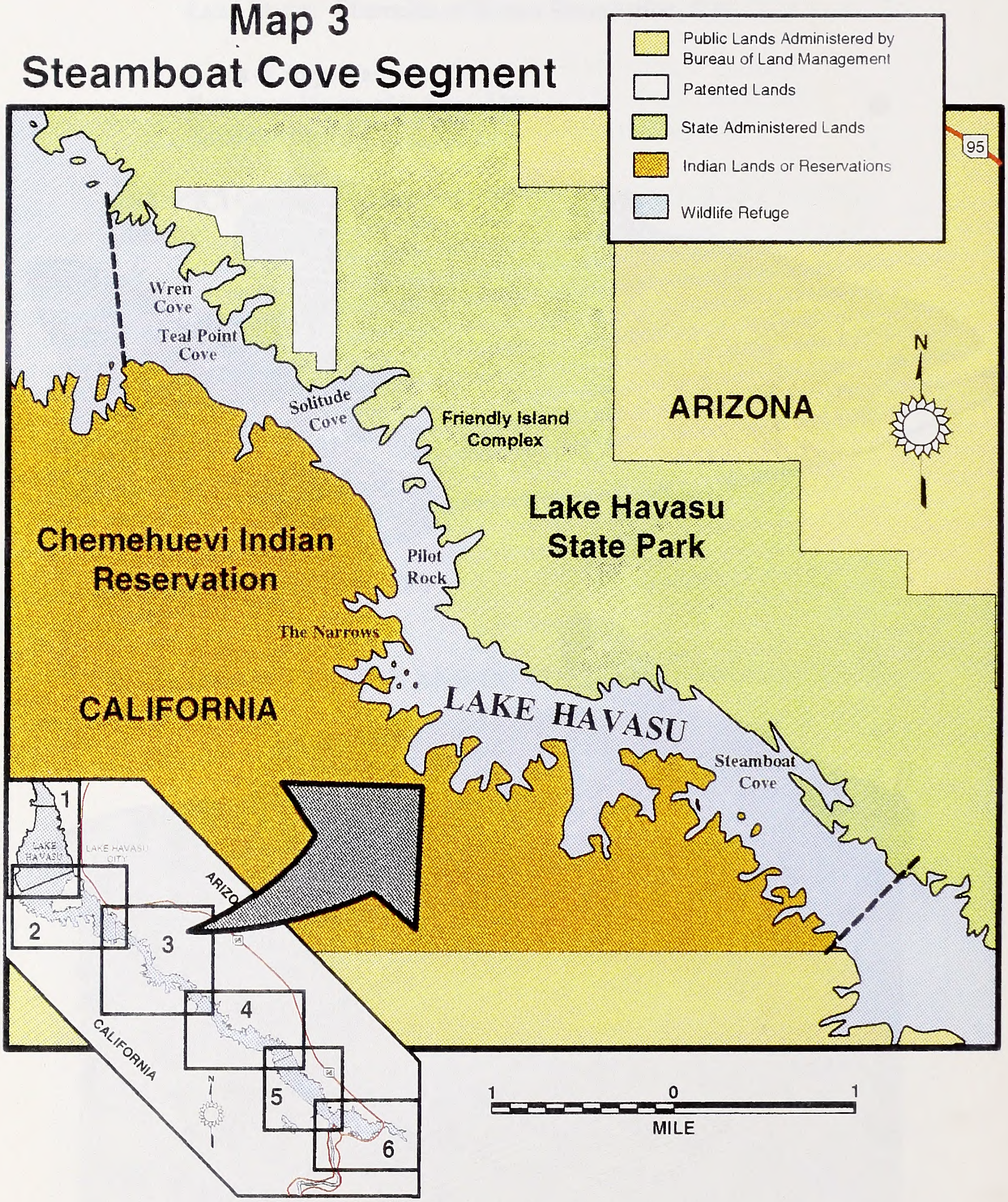
None







# Map 3
# Steamboat Cove Segment



# STEAMBOAT COVE SEGMENT

Acres of Improvement: 107
Estimated Hours of Labor: 47,628
Total Estimated Cost: $2,811,060

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 9,135 | Bass Shelters | $1,827,000 |
| 6,741 | Catfish Houses | $ 269,640 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 714,420 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

## EQUIPMENT

Necessary equipment such as pontoon boats, 4-WD vehicles, ATVs, generators, shelters, portable cement mixers, camping equipment, etc. are not included. These items will be determined as planning progresses.

## VOLUNTEERS AND FINANCIAL SPONSORS

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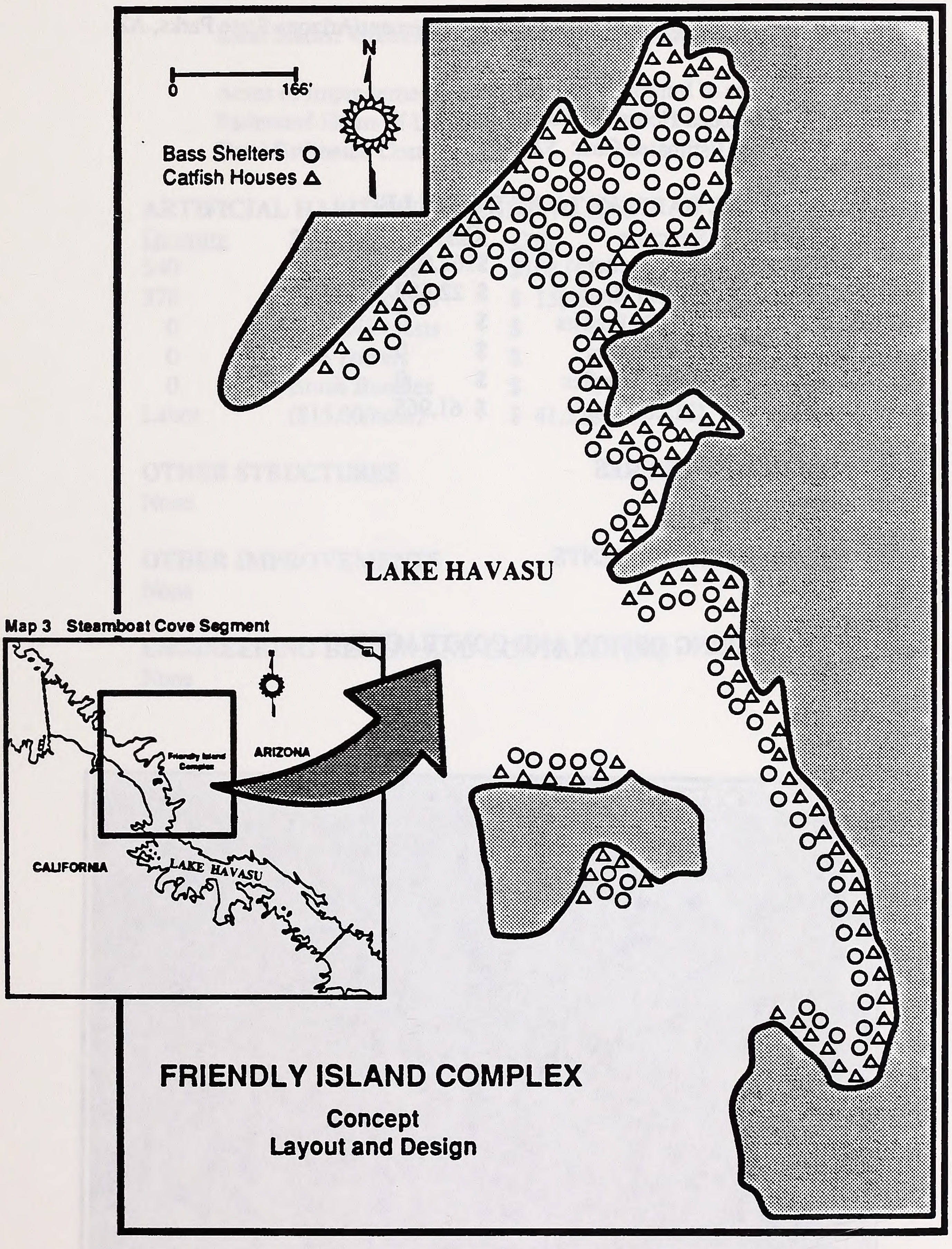
## STEAMBOAT COVE SEGMENT

Wren Cove, Arizona

Friendly Island Complex, Arizona



**FRIENDLY ISLAND COMPLEX**

Concept
Layout and Design

# WREN COVE

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 9
Estimated Hours of Labor: 4,131
Total Estimated Cost: $246,645

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 810 | Bass Shelters | $162,000 |
| 567 | Catfish Houses | $ 22,680 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 61,965 |

## OTHER STRUCTURES

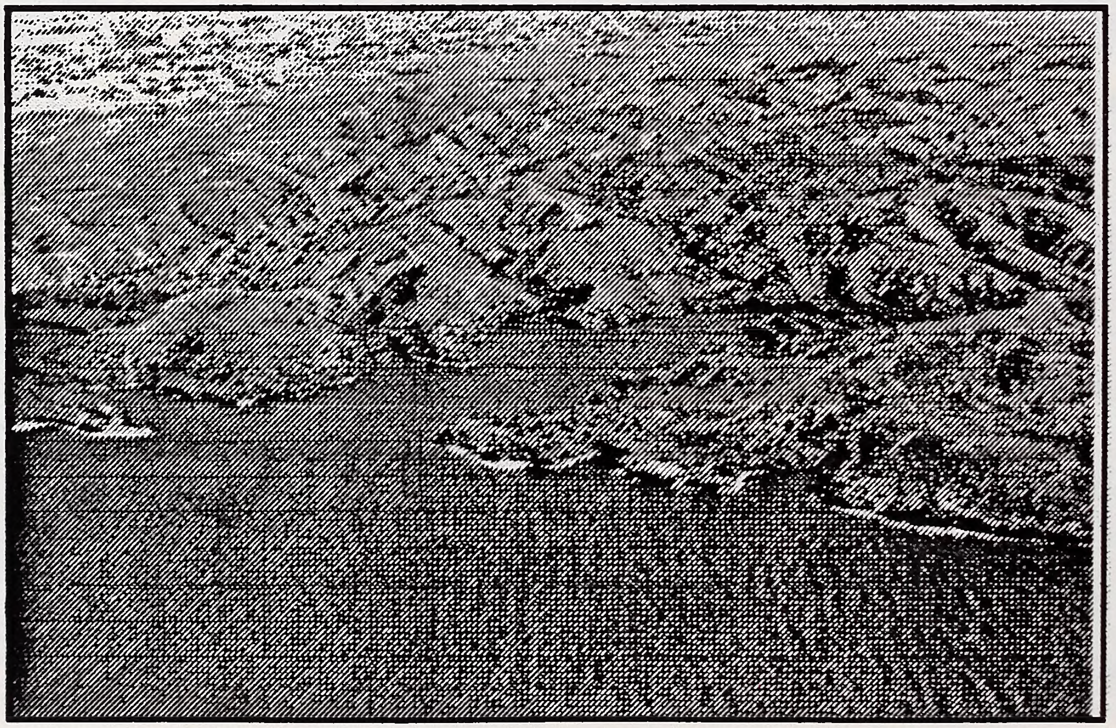
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# TEAL POINT

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 6
Estimated Hours of Labor: 2,754
Total Estimated Cost: $164,430

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 540 | Bass Shelters | $108,000 |
| 378 | Catfish Houses | $ 15,120 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 41,310 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

# SOLITUDE COVE

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 20
Estimated Hours of Labor: 9,180
Total Estimated Cost: $548,100

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 1,800 | Bass Shelters | $360,000 |
| 1,260 | Catfish Houses | $ 50,400 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $137,700 |

## OTHER STRUCTURES

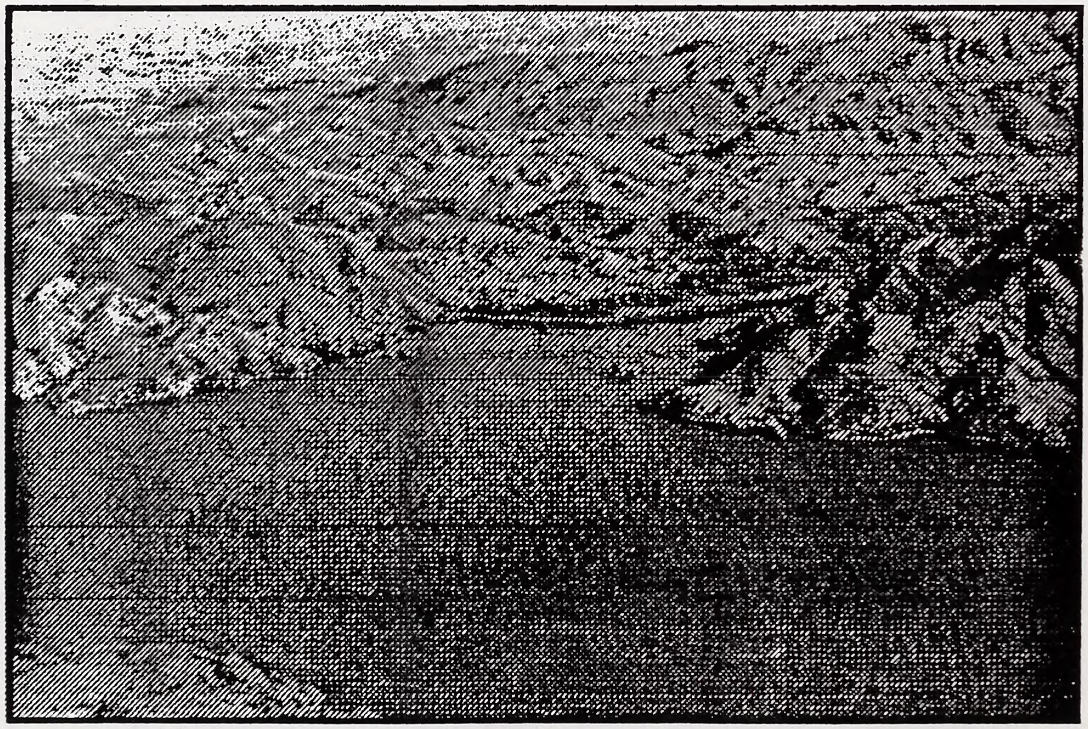
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# FRIENDLY ISLAND COMPLEX

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 16
Estimated Hours of Labor: 7,344
Total Estimated Cost: $438,480

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 1,440 | Bass Shelters | $288,000 |
| 1,008 | Catfish Houses | $ 40,320 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $110,160 |

## OTHER STRUCTURES

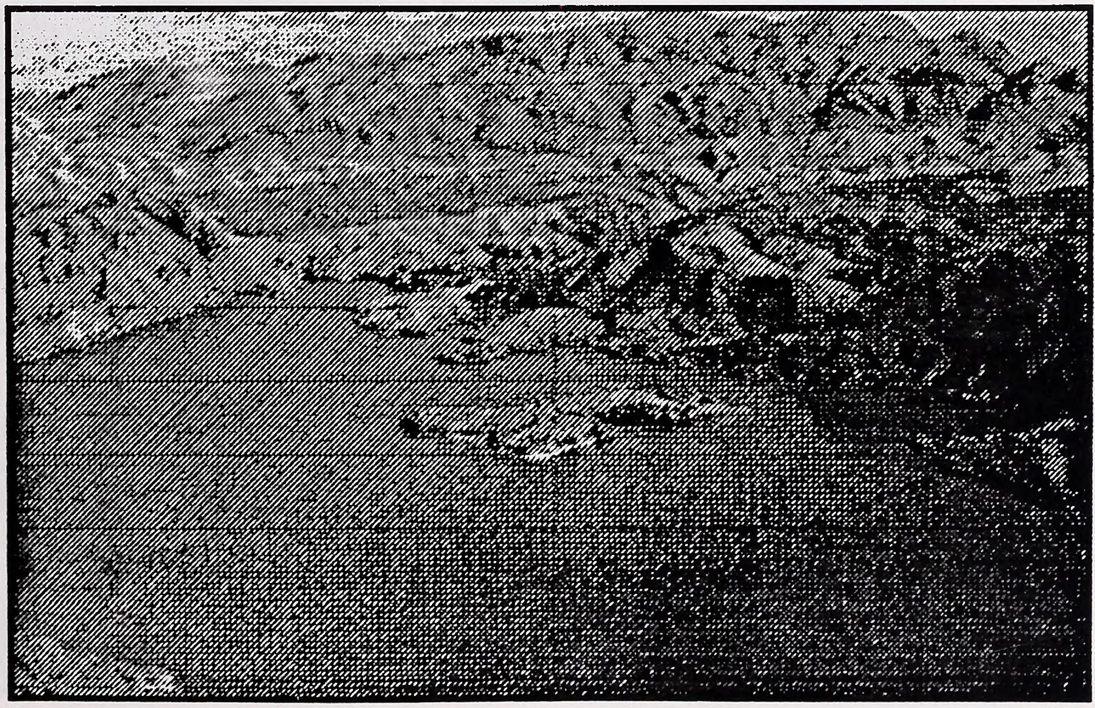
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# PILOT ROCK

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 10
Estimated Hours of Labor: 4,590
Total Estimated Cost: $274,050

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 900 | Bass Shelters | $180,000 |
| 630 | Catfish Houses | $ 25,200 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 68,850 |

## OTHER STRUCTURES

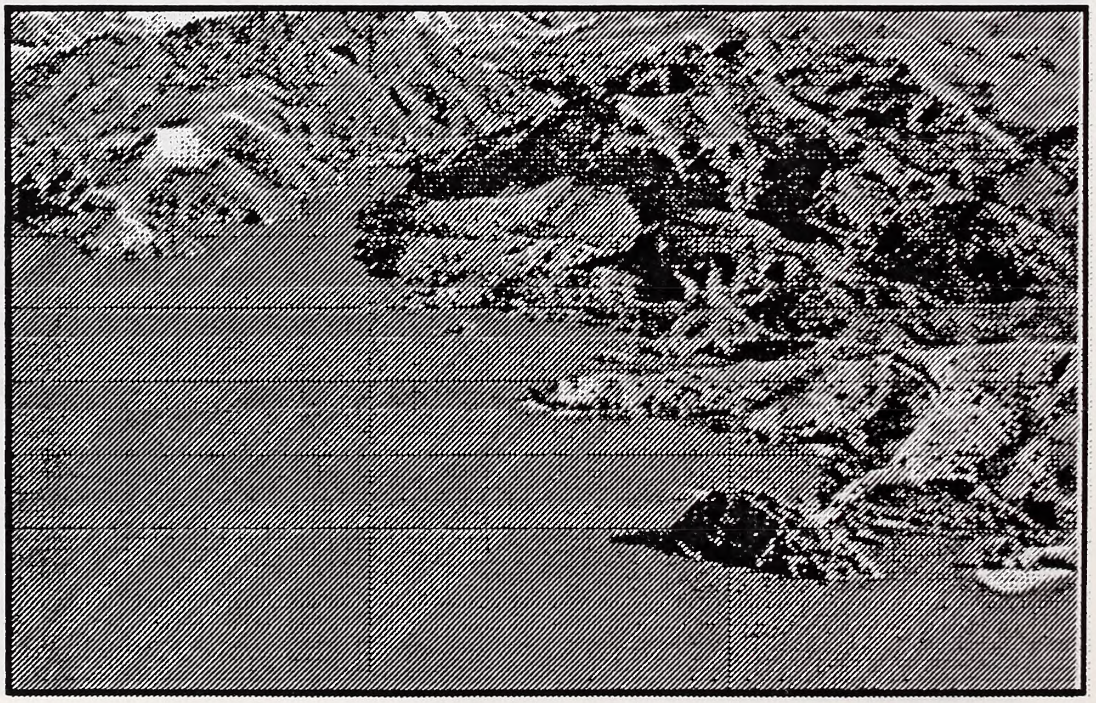
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



## THE NARROWS

Land Status: Chemeheuvi Indian Reservation, CA

Acres of Improvement: 35
Estimated Hours of Labor: 16,065
Total Estimated Cost: $959,175

### ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 3,150 | Bass Shelters | $630,000 |
| 2,205 | Catfish Houses | $ 88,200 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $240,975 |

### OTHER STRUCTURES

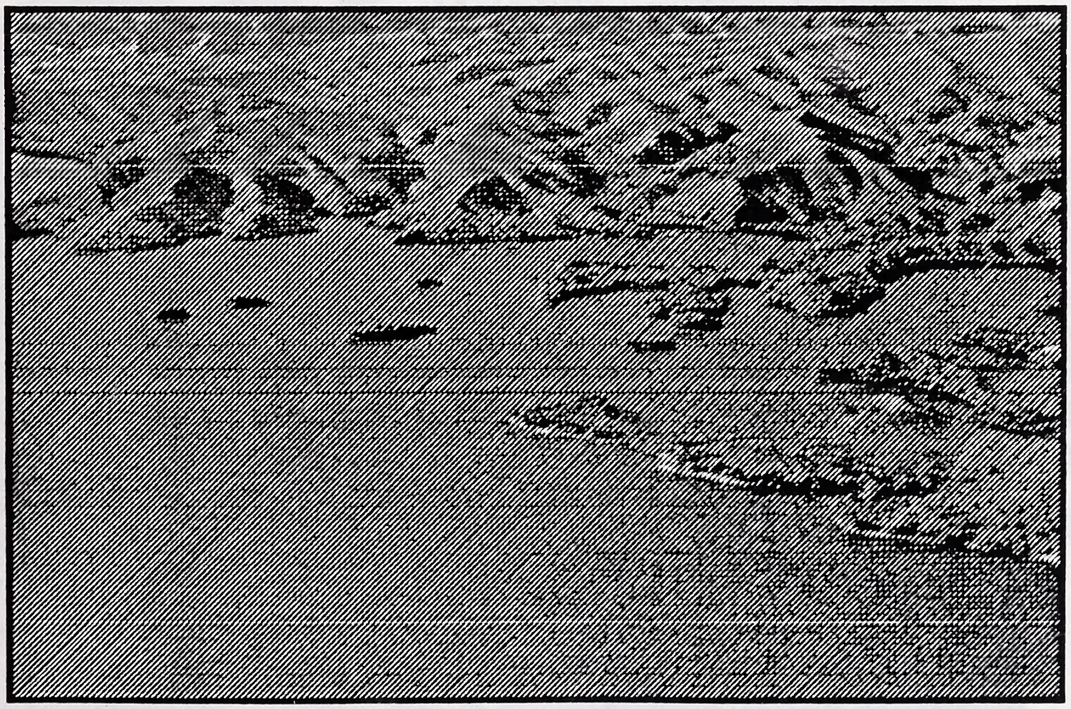
None

### OTHER IMPROVEMENTS

None

### ENGINEERING DESIGN AND CONTRACTING

None



# STEAMBOAT COVE

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 11
Estimated Hours of Labor: 3,564
Total Estimated Cost: $180,180

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 495 | Bass Shelters | $99,000 |
| 693 | Catfish Houses | $27,720 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| * | Brush Bundles | * |
| Labor | ($15.00/hour) | $53,460 |

## OTHER STRUCTURES

None

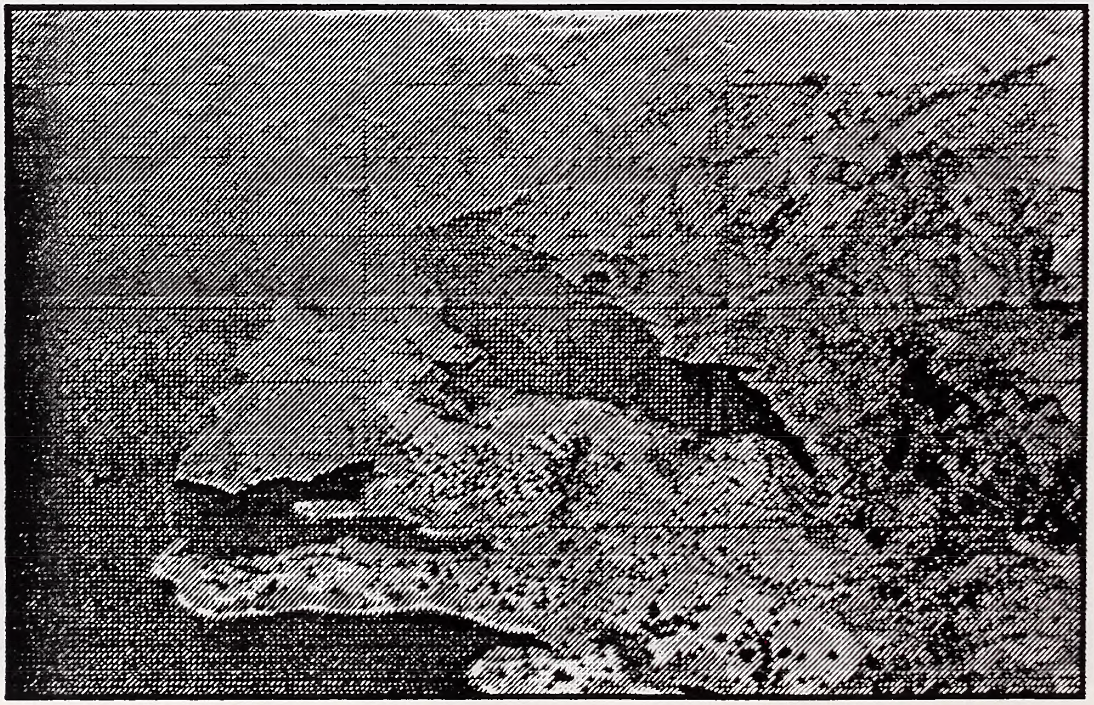
## OTHER IMPROVEMENTS

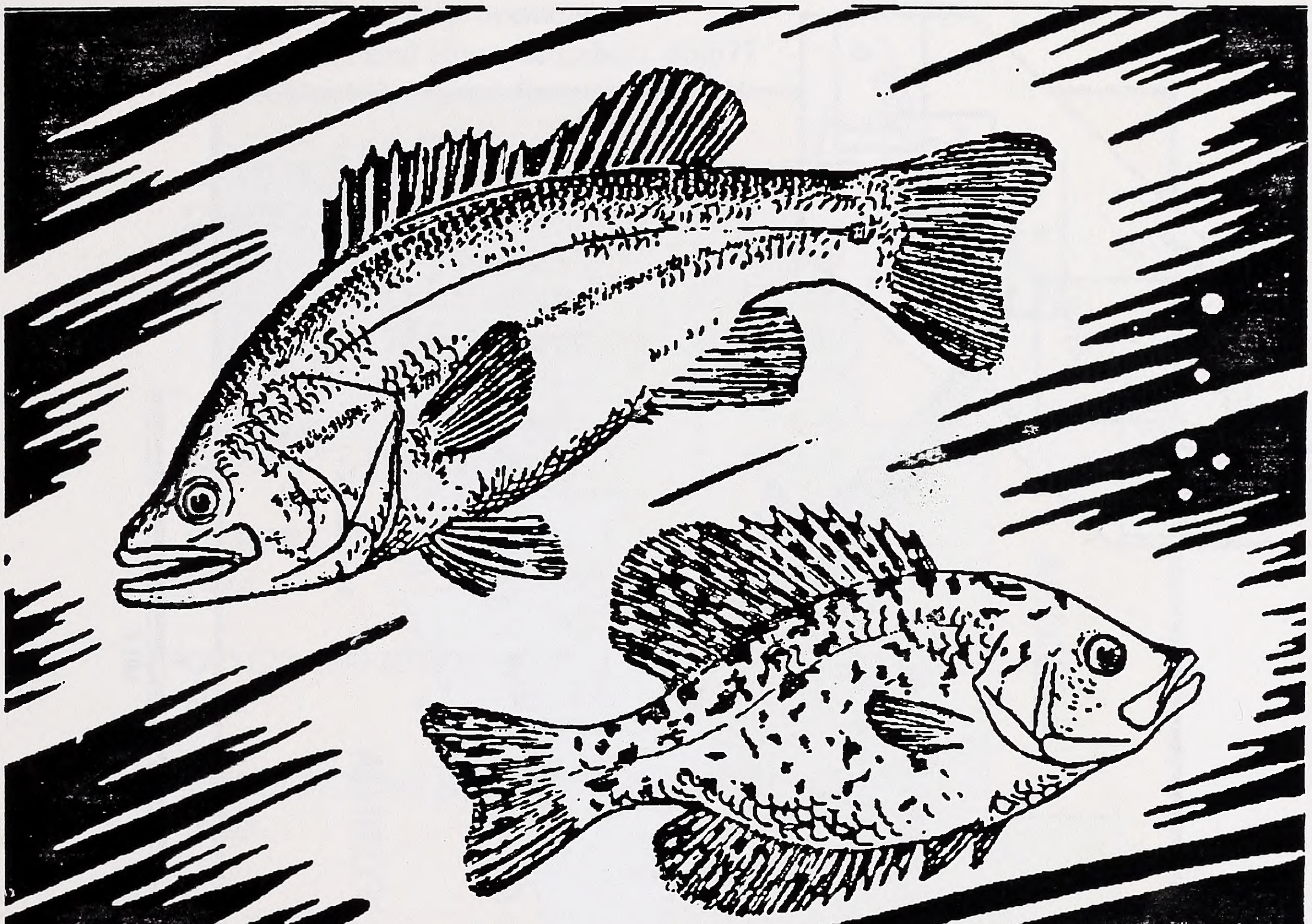
None

## ENGINEERING DESIGN AND CONTRACTING

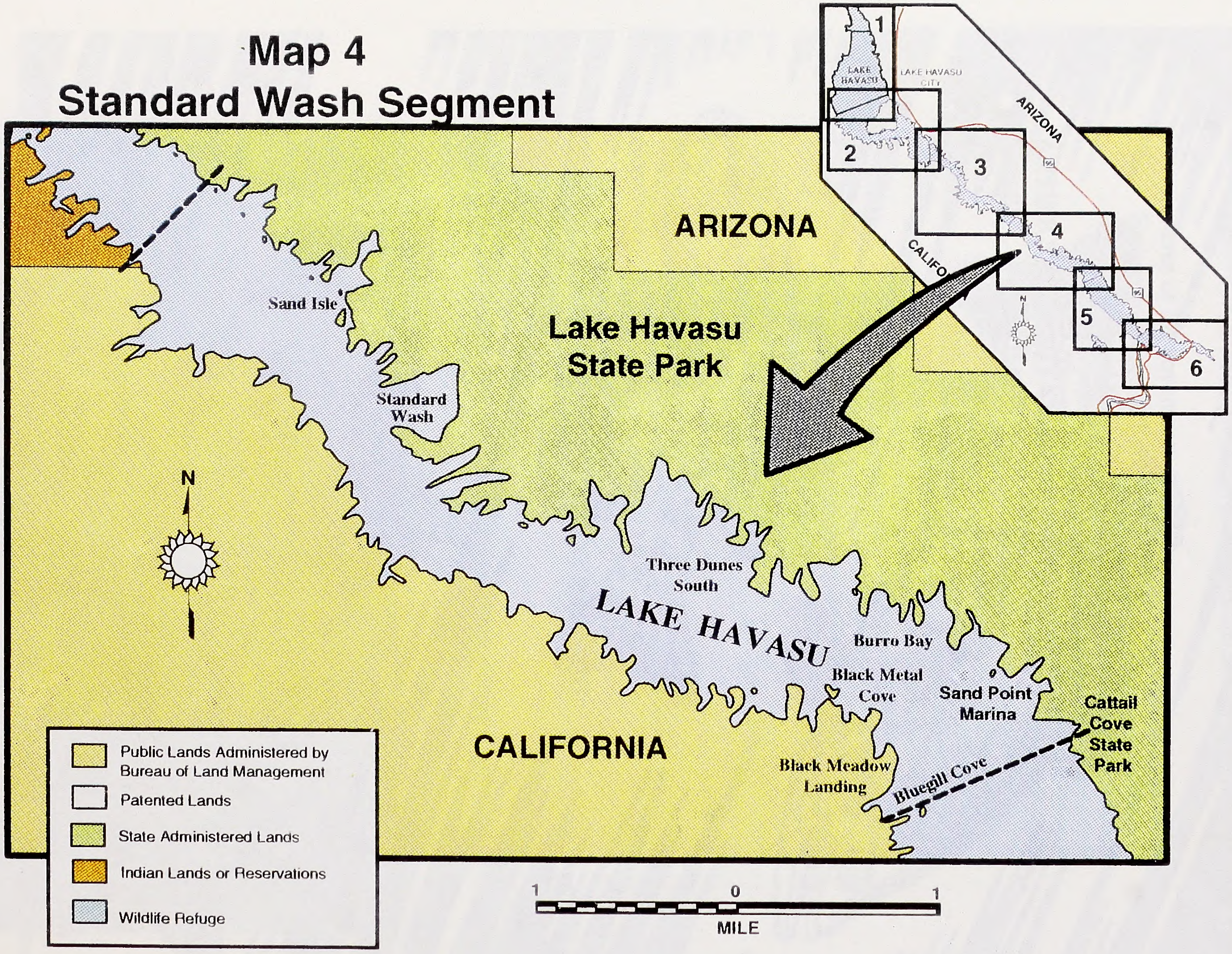
None

*NOTE*: Brush Bundles were added to the cove during a previous project.





# Map 4
## Standard Wash Segment



# STANDARD WASH SEGMENT

Acres of Improvement: 96
Estimated Hours of Labor: 46,677
Total Estimated Cost: $3,584,625

**ARTIFICIAL HABITAT TO BE INSTALLED**

| Quantity | Structure | Cost |
|---|---|---|
| 8,640 | Bass Shelters | $1,728,000 |
| 6,048 | Catfish Houses | $ 241,920 |
| 871 | Fish 'N Forests | $ 914,550 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 700,155 |

**OTHER STRUCTURES**
None

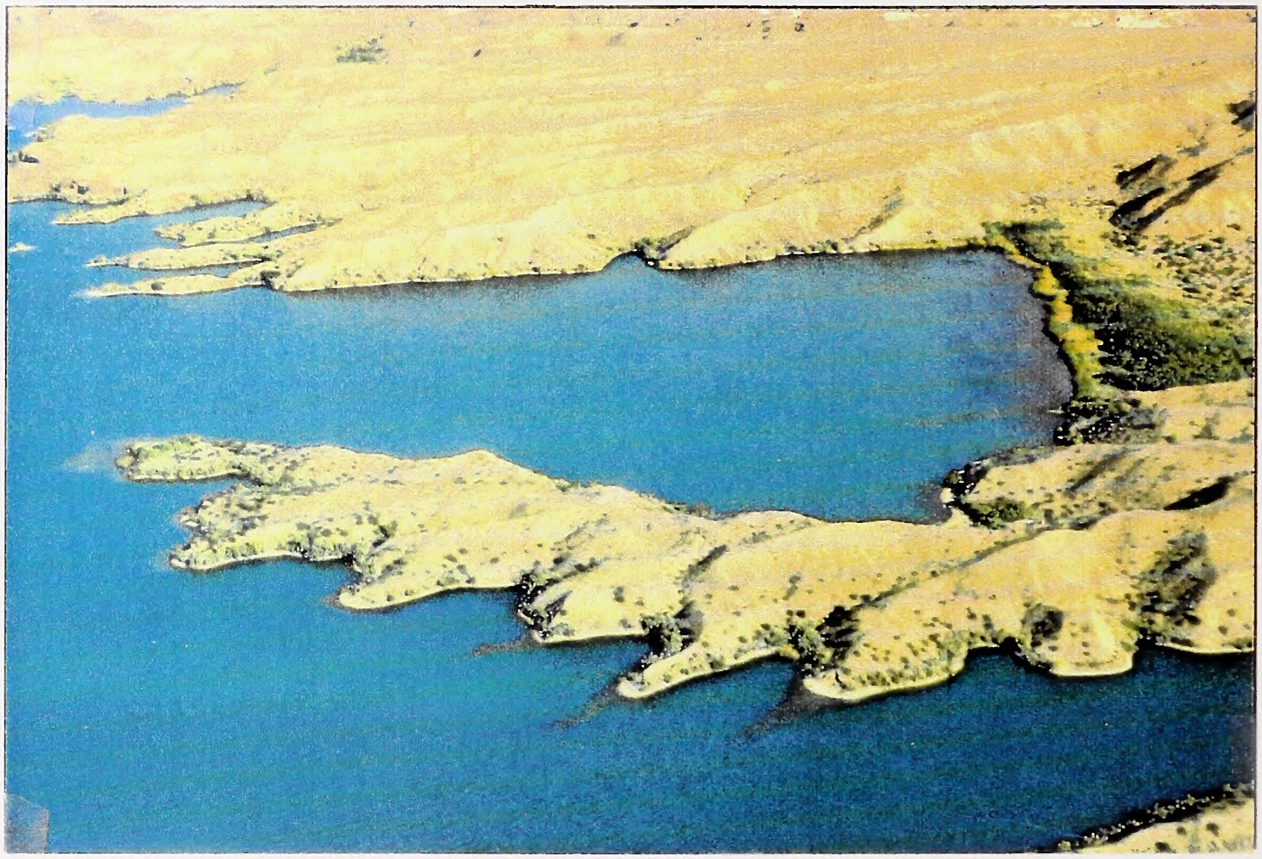
**OTHER IMPROVEMENTS**
None

**ENGINEERING DESIGN AND CONTRACTING**
None

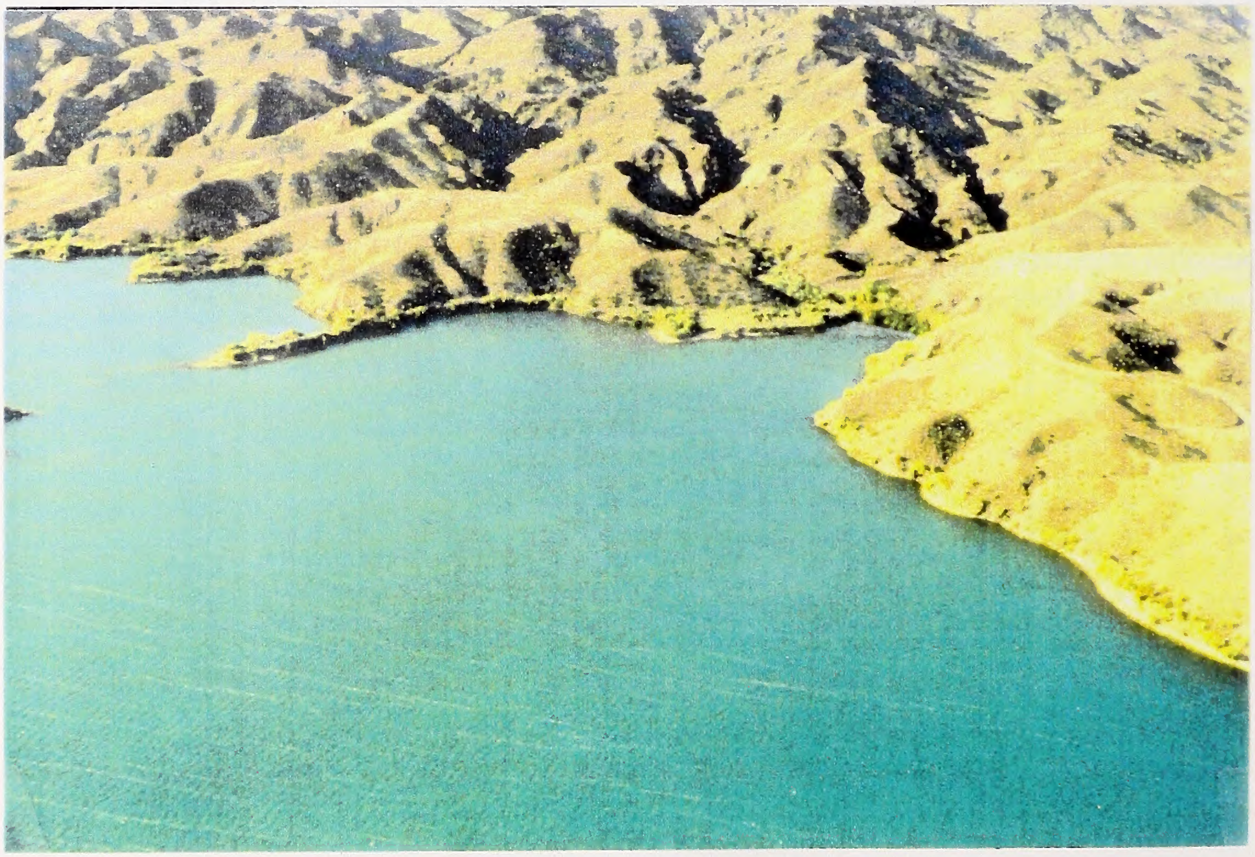
**EQUIPMENT**
Necessary equipment such as pontoon boats, 4-WD vehicles, ATVs, generators, shelters, portable cement mixers, camping equipment, etc. are not included. These items will be determined as planning progresses.

**VOLUNTEERS AND FINANCIAL SPONSORS**
Funds and responsible organizations to do the work are being sought by Anglers United. Contact: Dave LaMorte - (602) 839-0660 or Mike Henderson - (602) 855-8017.

## STANDARD WASH SEGMENT



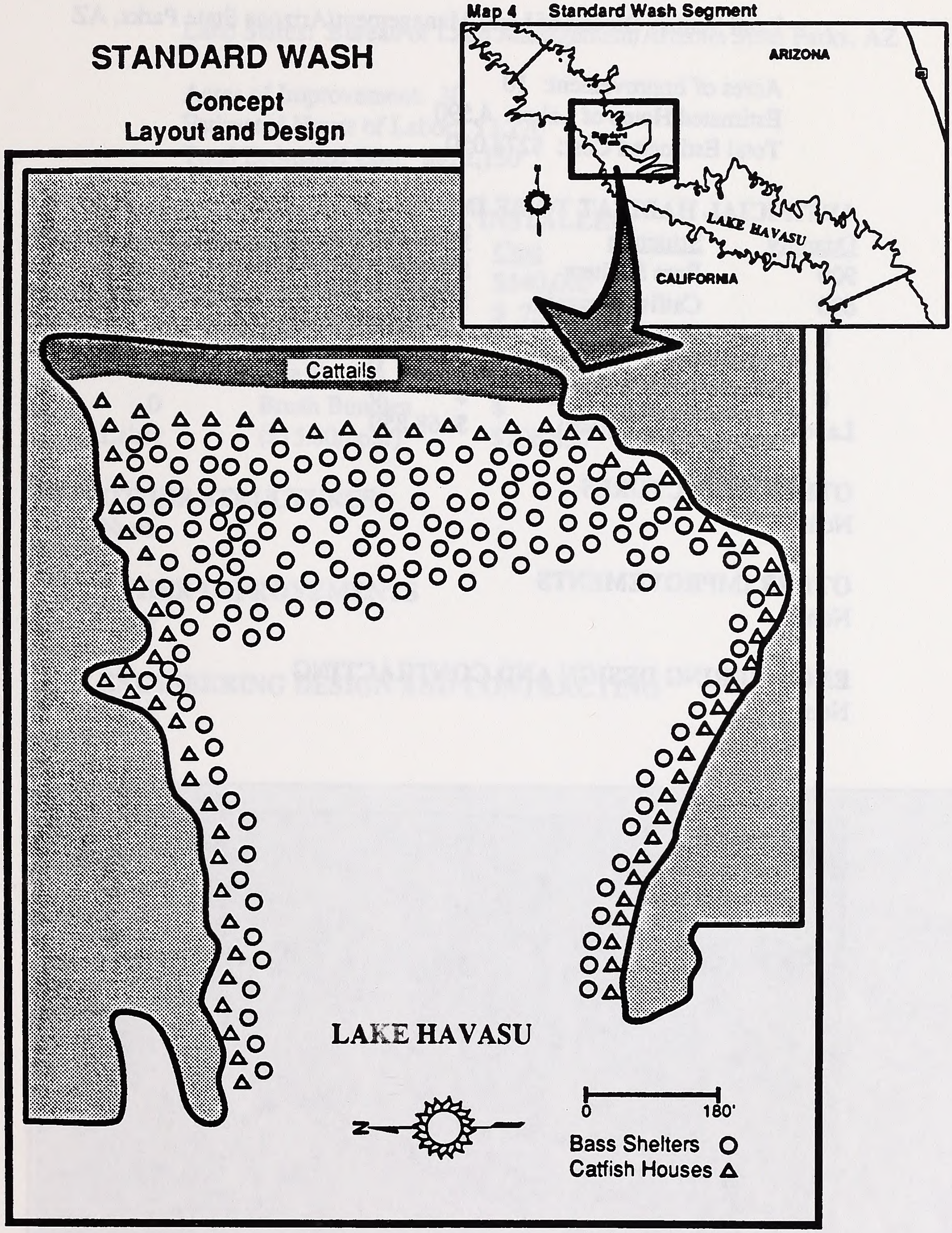
Standard Wash, Arizona



Bluegill Cove, California

## STANDARD WASH

### Concept
### Layout and Design



# SAND ISLE

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 10
Estimated Hours of Labor: 4,590
Total Estimated Cost: $274,050

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 900 | Bass Shelters | $180,000 |
| 630 | Catfish Houses | $ 25,200 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 68,850 |

## OTHER STRUCTURES

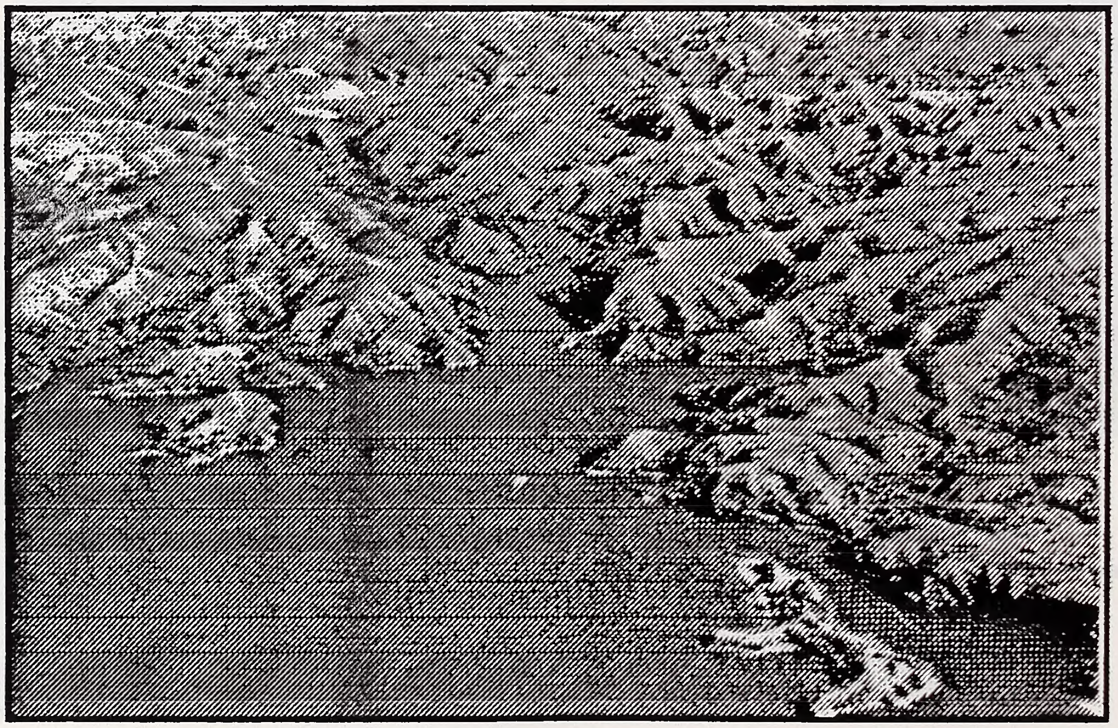
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



## STANDARD WASH

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 30
Estimated Hours of Labor: 13,770
Total Estimated Cost: $822,150

### ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 2,700 | Bass Shelters | $540,000 |
| 1,890 | Catfish Houses | $ 75,600 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $206,550 |

### OTHER STRUCTURES

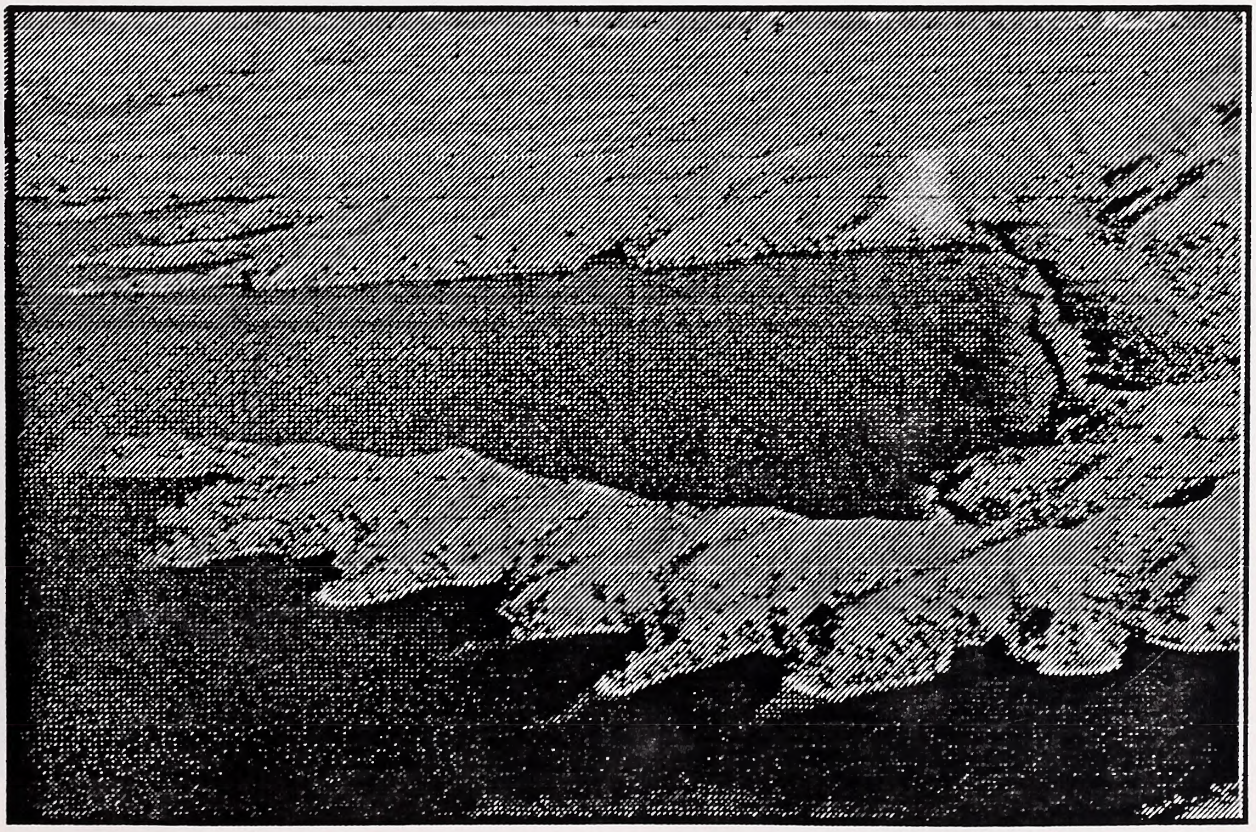
None

### OTHER IMPROVEMENTS

None

### ENGINEERING DESIGN AND CONTRACTING

None



# THREE DUNES SOUTH

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 19
Estimated Hours of Labor: 8,721
Total Estimated Cost: $520,695

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 1,710 | Bass Shelters | $342,000 |
| 1,197 | Catfish Houses | $ 47,880 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $130,815 |

## OTHER STRUCTURES

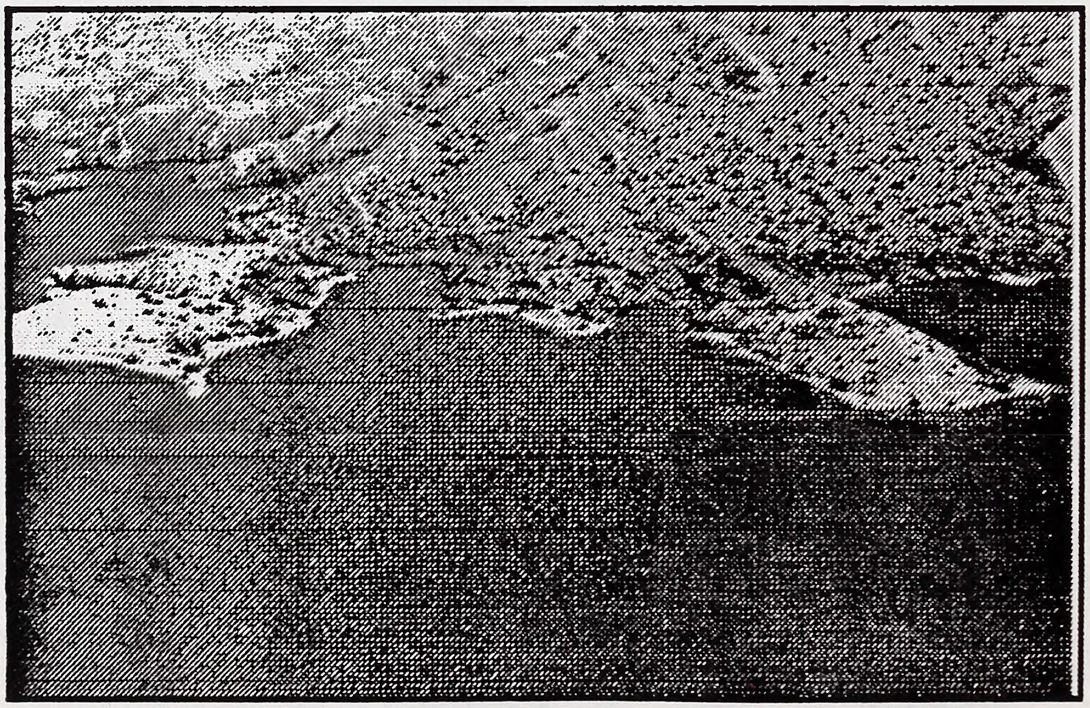
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# BURRO BAY

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 10
Estimated Hours of Labor: 4,590
Total Estimated Cost: $274,050

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 900 | Bass Shelters | $180,000 |
| 630 | Catfish Houses | $ 25,200 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 68,850 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

# BLACK METAL COVE

Land Status: Bureau of Land Management, CA

Acres of Improvement: 5
Estimated Hours of Labor: 4,908
Total Estimated Cost: $1,090,770

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 450 | Bass Shelters | $ 90,000 |
| 315 | Catfish Houses | $ 12,600 |
| 871 | Fish 'N Forests | $914,550 |
| 0 | Tire Tower | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 73,620 |

## OTHER STRUCTURES

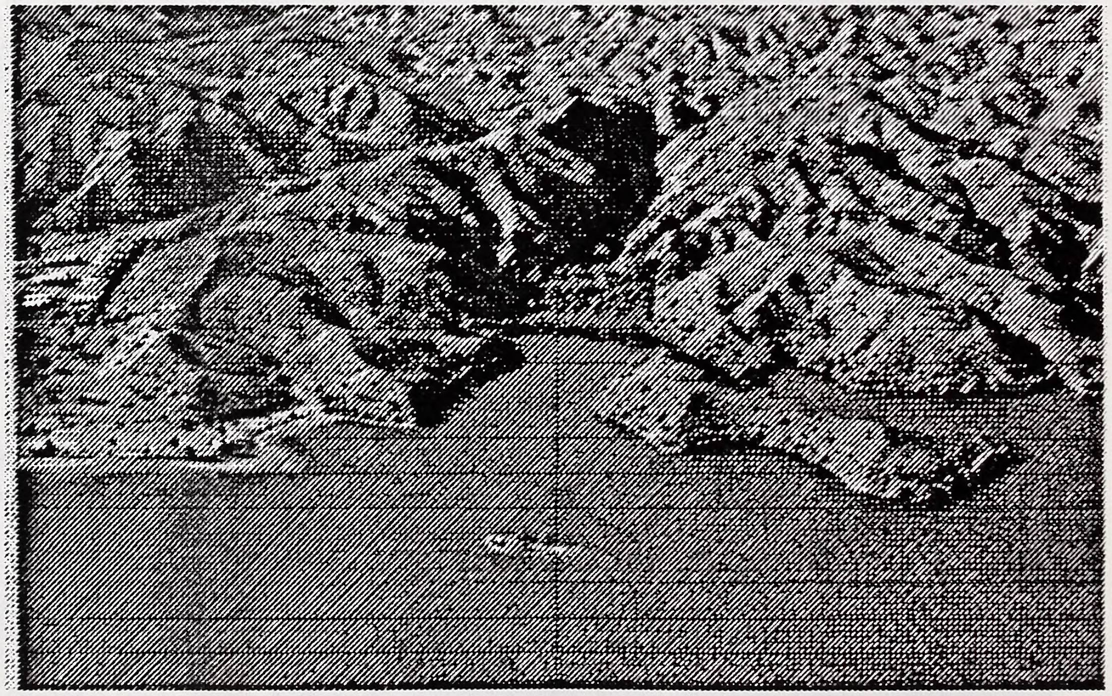
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# BLACK MEADOW LANDING

Land Status: Bureau of Land Management, CA

Acres of Improvement: 6
Estimated Hours of Labor: 2,754
Total Estimated Cost: $164,430

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 540 | Bass Shelters | $108,000 |
| 378 | Catfish Houses | $ 15,120 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 41,310 |

## OTHER STRUCTURES

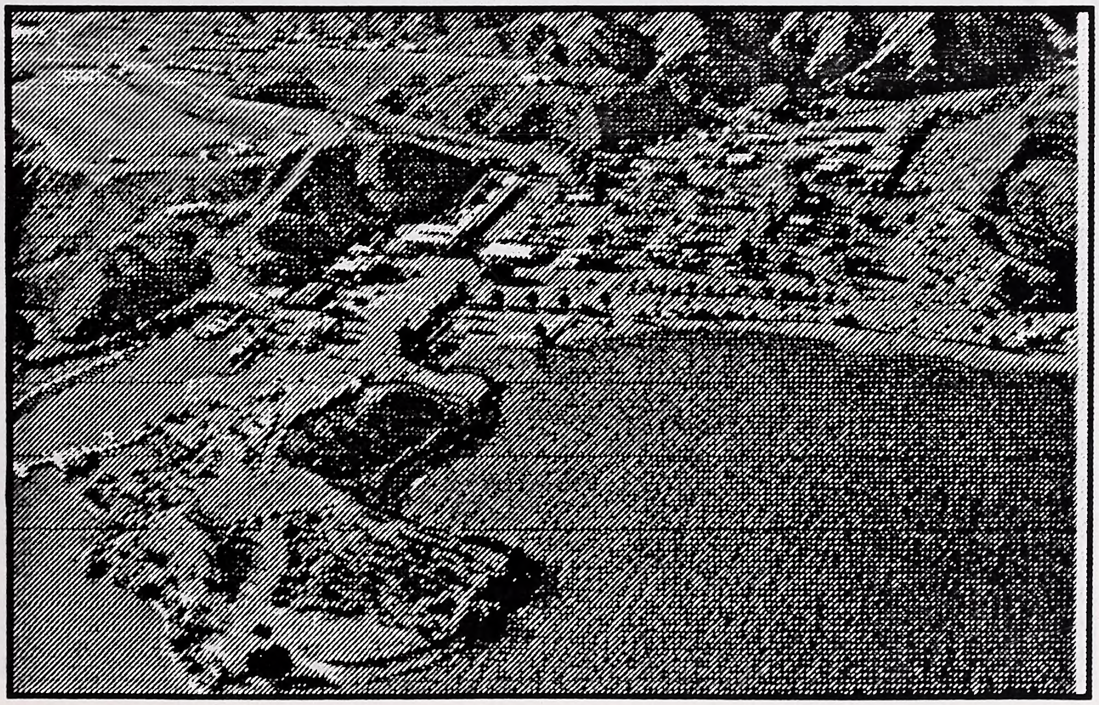
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



## SAND POINT MARINA

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 6
Estimated Hours of Labor: 2,754
Total Estimated Cost: $164,430

### ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 540 | Bass Shelters | $108,000 |
| 378 | Catfish Houses | $ 15,120 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 41,310 |

### OTHER STRUCTURES

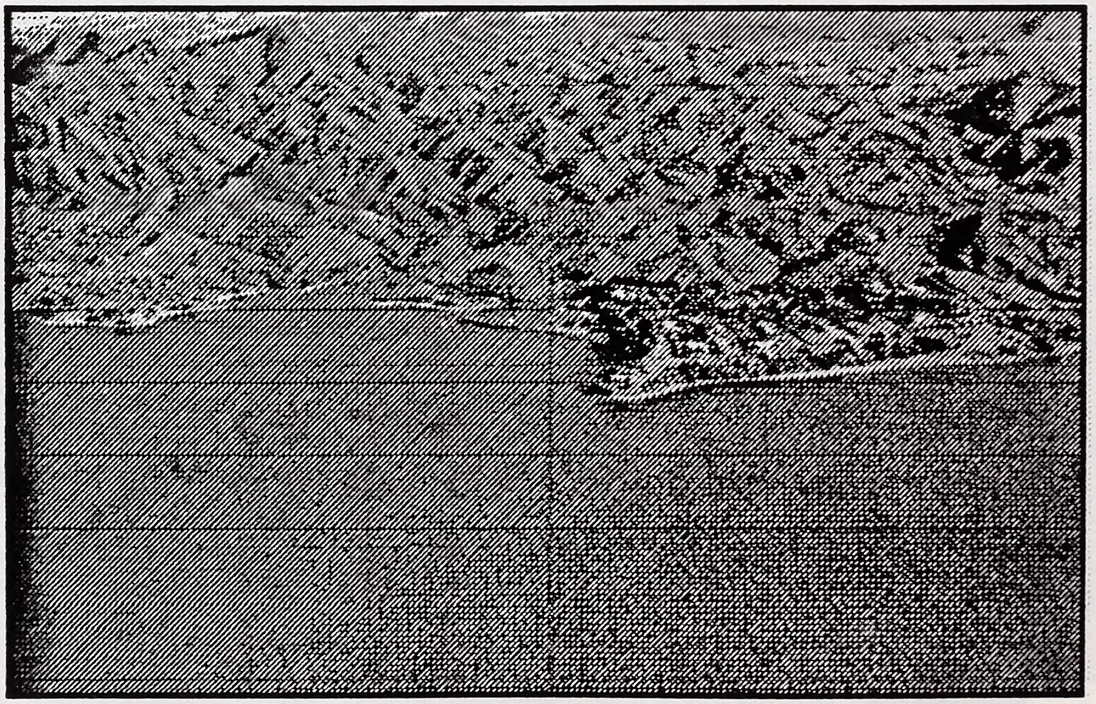
None

### OTHER IMPROVEMENTS

None

### ENGINEERING DESIGN AND CONTRACTING

None



# BLUEGILL COVE

Land Status: Bureau of Land Management, CA

Acres of Improvement: 10
Estimated Hours of Labor: 4,590
Total Estimated Cost: $274,050

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 900 | Bass Shelters | $180,000 |
| 630 | Catfish Houses | $ 25,200 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 68,850 |

## OTHER STRUCTURES

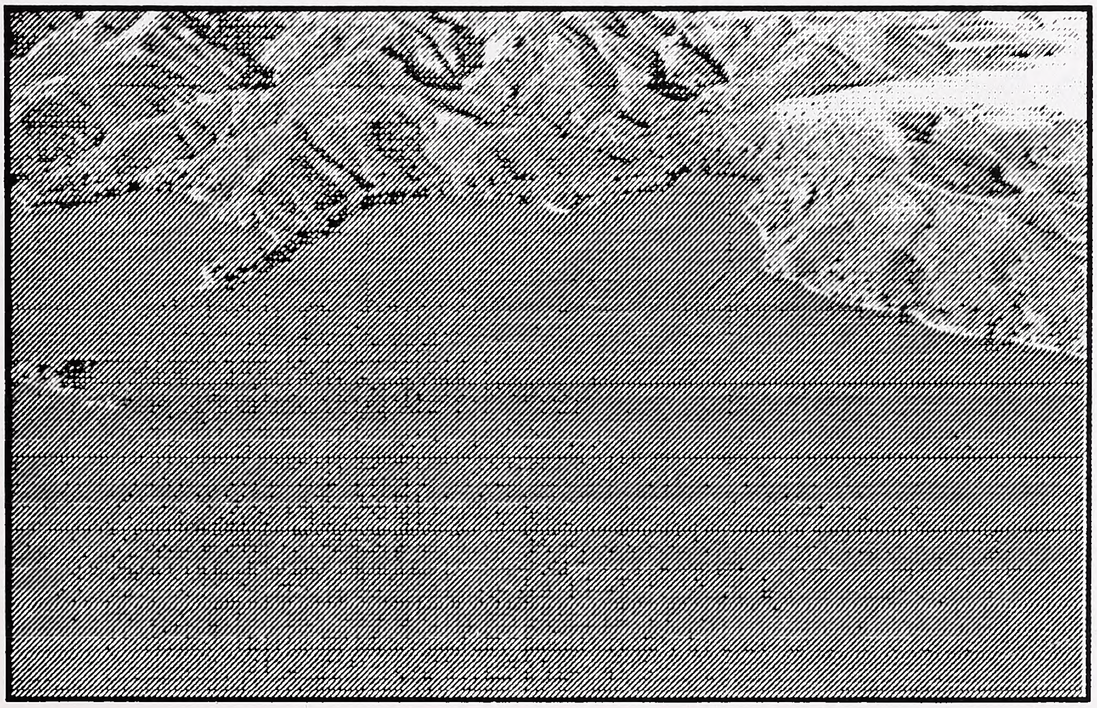
None

## OTHER IMPROVEMENTS

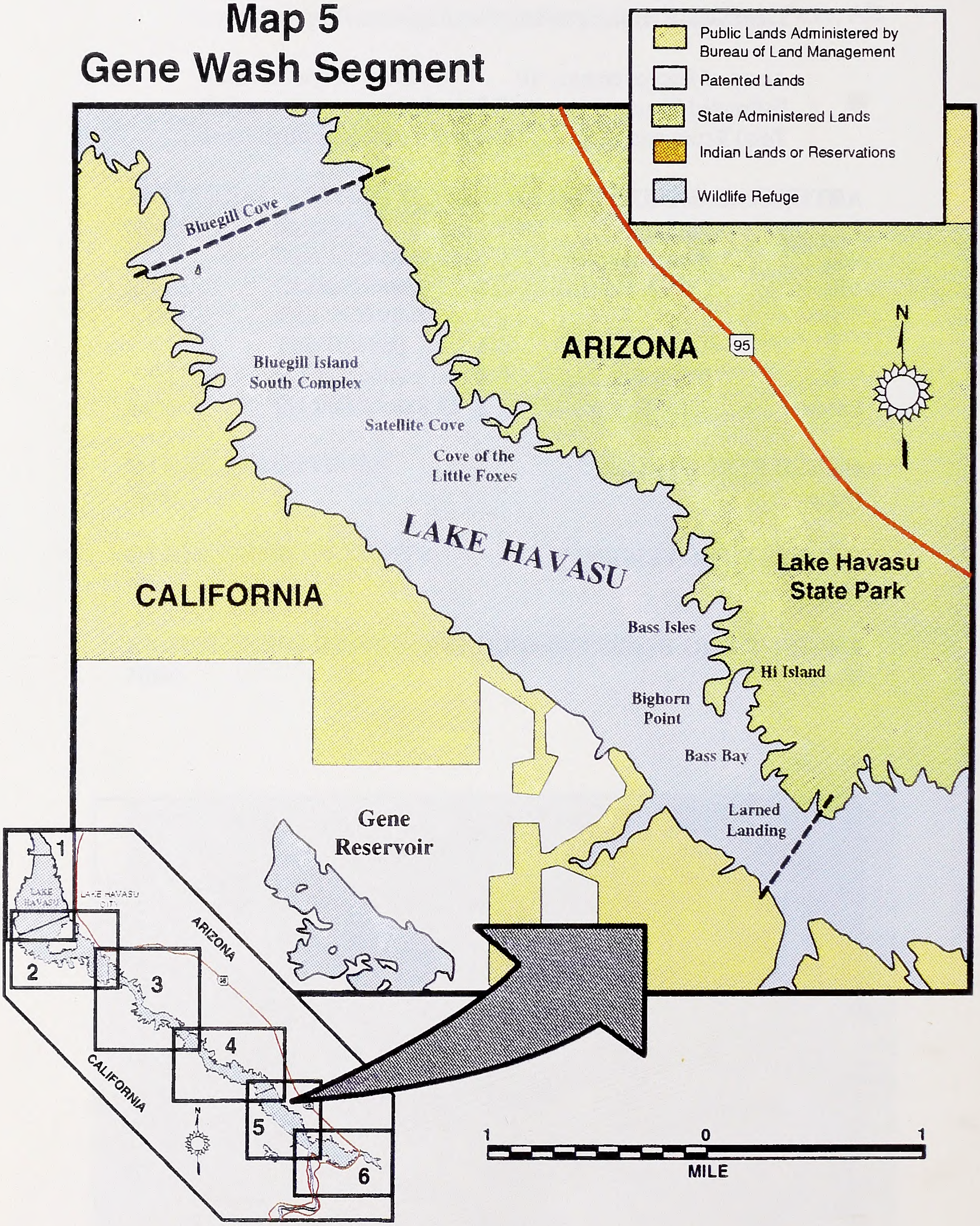
None

## ENGINEERING DESIGN AND CONTRACTING

None



# Map 5
# Gene Wash Segment



# GENE WASH SEGMENT

Acres of Improvement: 68
Estimated Hours of Labor: 30,294
Total Estimated Cost: $2,753,280

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 5,940 | Bass Shelters | $1,188,000 |
| 4,158 | Catfish Houses | $ 166,320 |
| 871 | Fish 'N Forests | $ 914,550 |
| 300 | Tire Towers | $ 30,000 |
| 7,800 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $ 454,410 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

## EQUIPMENT

Necessary equipment such as pontoon boats, 4-WD vehicles, ATVs, generators, shelters, portable cement mixers, camping equipment, etc. are not included. These items will be determined as planning progresses.

## VOLUNTEERS AND FINANCIAL SPONSORS

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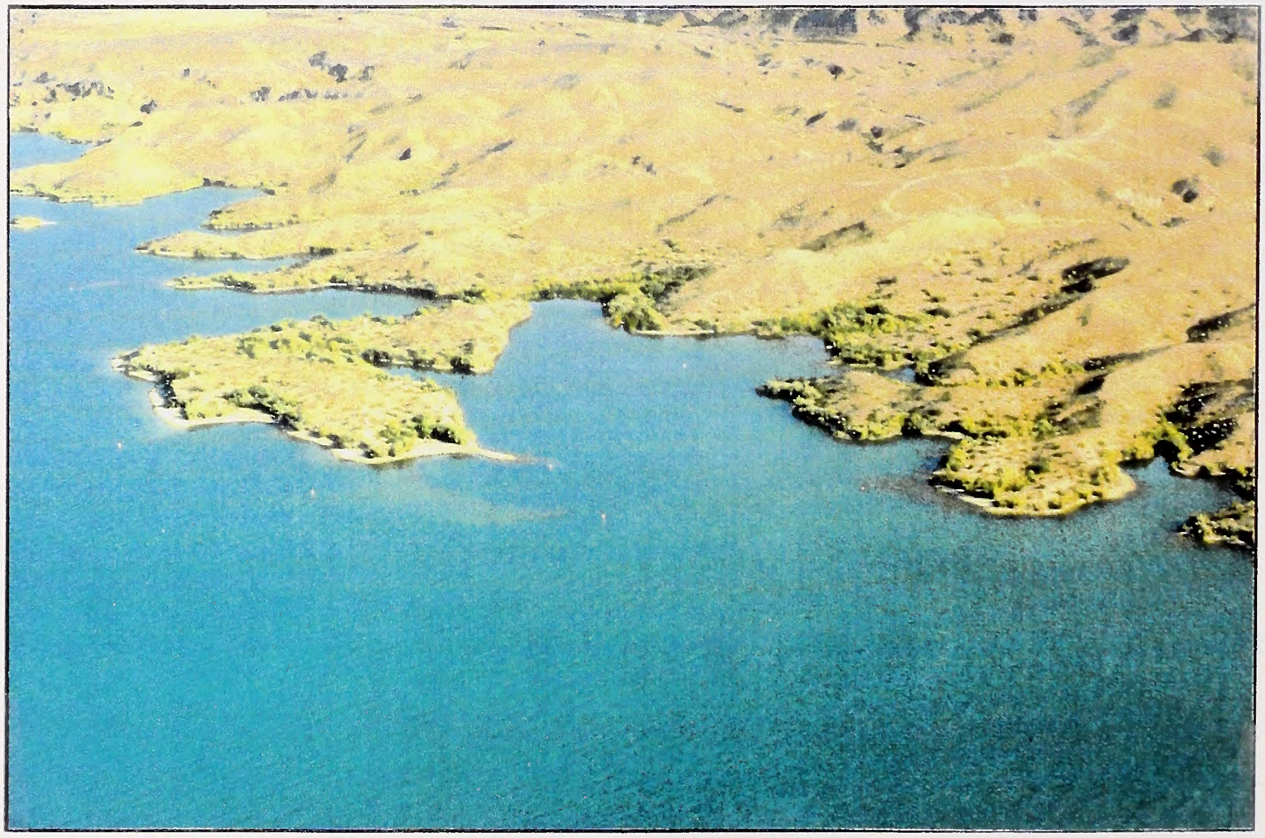
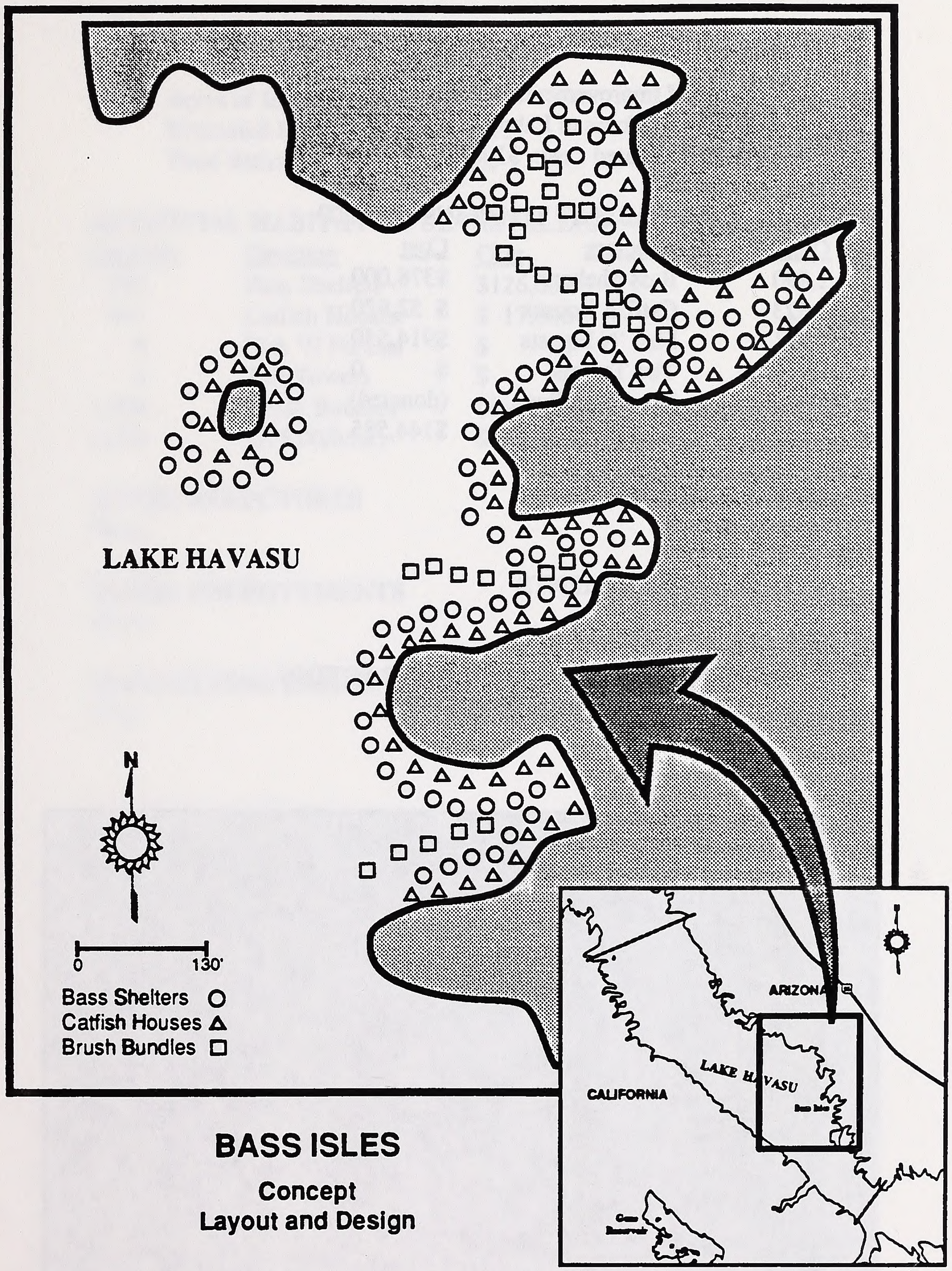
# GENE WASH SEGMENT

Bass Isles, Arizona



Hi Island and Bighorn Point, California



BASS ISLES

Concept
Layout and Design

Map 5 Gene Wash Segment

# BLUEGILL ISLAND SOUTH COMPLEX

Land Status: Bureau of Land Management, CA

Acres of Improvement: 21
Estimated Hours of Labor: 9,639
Total Estimated Cost: $1,490,055

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 1,890 | Bass Shelters | $378,000 |
| 1,323 | Catfish Houses | $ 52,920 |
| 871 | Fish 'N Forests | $914,550 |
| 0 | Tire Towers | $ 0 |
| 2400 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $144,585 |

## OTHER STRUCTURES

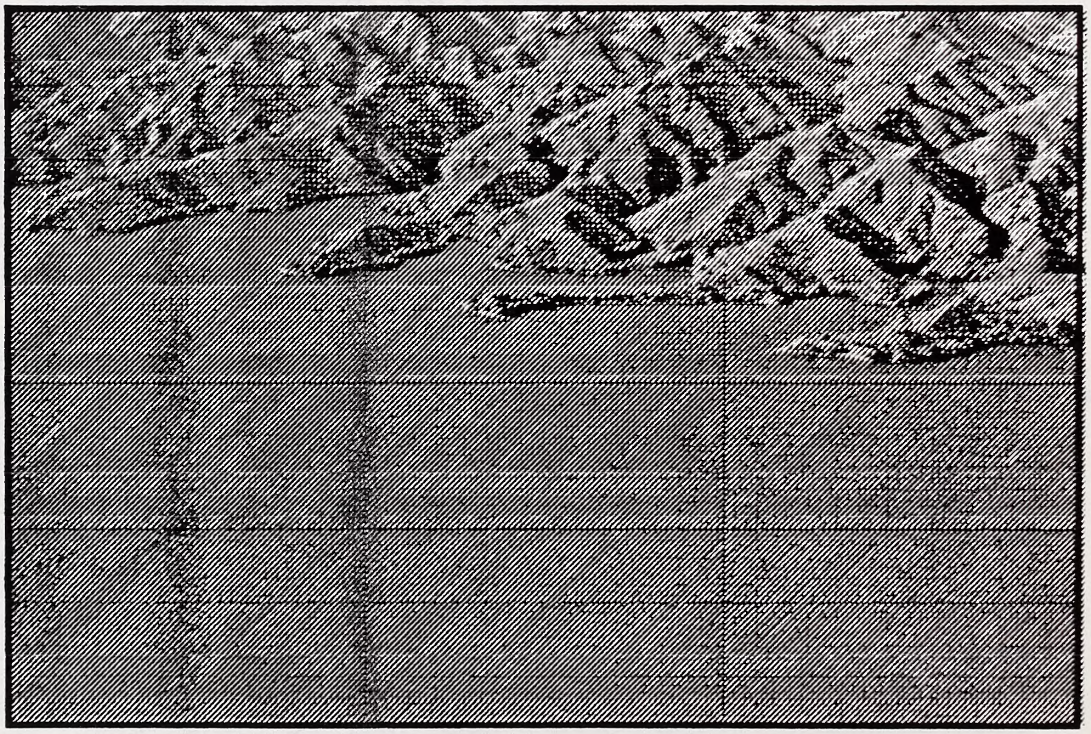
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# SATELLITE COVE

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 7
Estimated Hours of Labor: 3,213
Total Estimated Cost: $191,835

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 630 | Bass Shelters | $126,000 |
| 441 | Catfish Houses | $ 17,640 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 1,000 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $ 48,195 |

## OTHER STRUCTURES

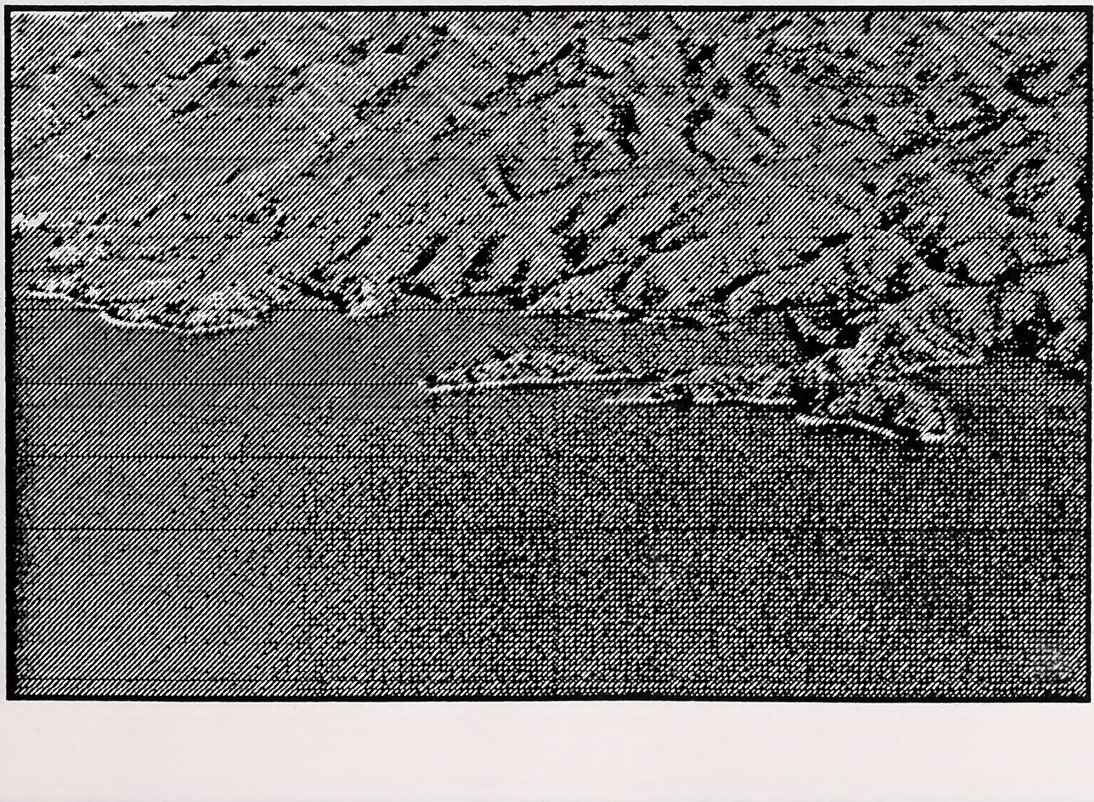
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# COVE OF THE LITTLE FOXES

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 4
Estimated Hours of Labor: 1,836
Total Estimated Cost: $109,620

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 360 | Bass Shelters | $ 72,000 |
| 252 | Catfish Houses | $ 10,080 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 800 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $ 27,540 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

# BASS ISLES

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 13
Estimated Hours of Labor: 5,967
Total Estimated Cost: $356,265

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 1,170 | Bass Shelters | $234,000 |
| 819 | Catfish Houses | $ 32,760 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 1,200 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $ 89,505 |

## OTHER STRUCTURES

None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None

# HI ISLAND

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 1
Estimated Hours of Labor: 450
Total Estimated Cost: $15,000

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 0 | Bass Shelters | $ 0 |
| 0 | Catfish Houses | $ 0 |
| 0 | Fish 'N Forests | $ 0 |
| 150 | Tire Towers | $15,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | (volunteer) | $ 0 |

## OTHER STRUCTURES

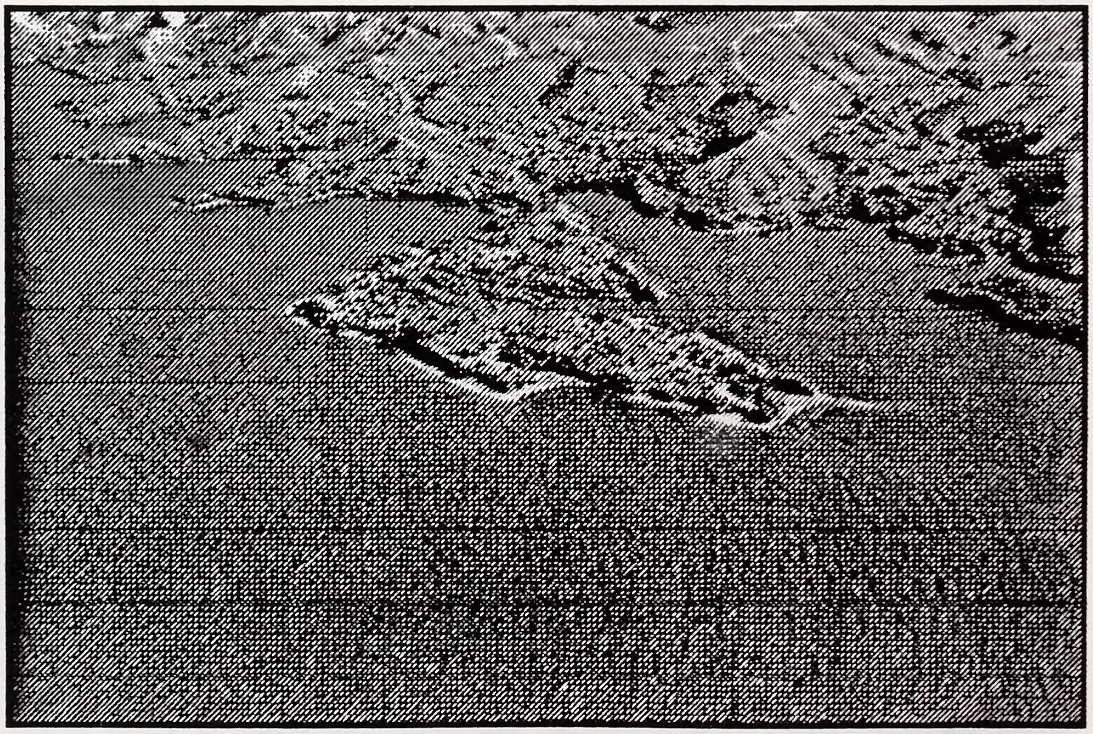
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



## BIGHORN POINT

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 11
Estimated Hours of Labor: 5,049
Total Estimated Cost: $301,455

### ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 990 | Bass Shelters | $198,000 |
| 693 | Catfish Houses | $2 7,720 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 1,200 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $ 75,735 |

### OTHER STRUCTURES

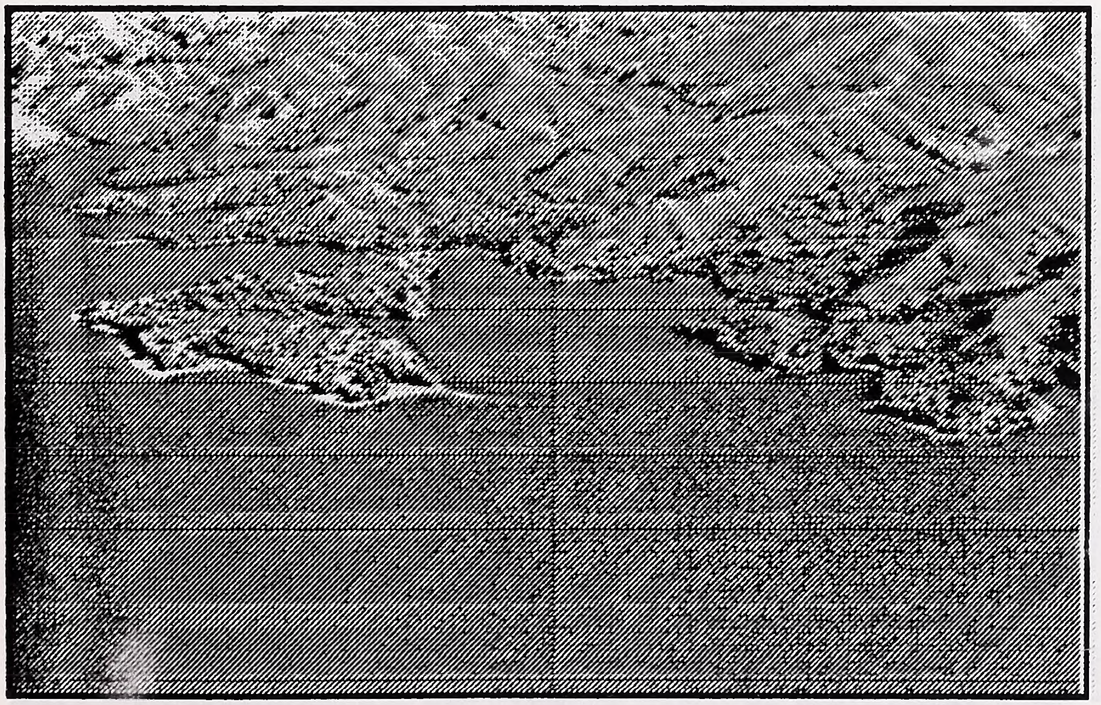
None

### OTHER IMPROVEMENTS

None

### ENGINEERING DESIGN AND CONTRACTING

None



# BASS BAY

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 10
Estimated Hours of Labor: 4,590
Total Estimated Cost: $274,050

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 900 | Bass Shelters | $180,000 |
| 630 | Catfish Houses | $ 25,200 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 68,850 |

## OTHER STRUCTURES

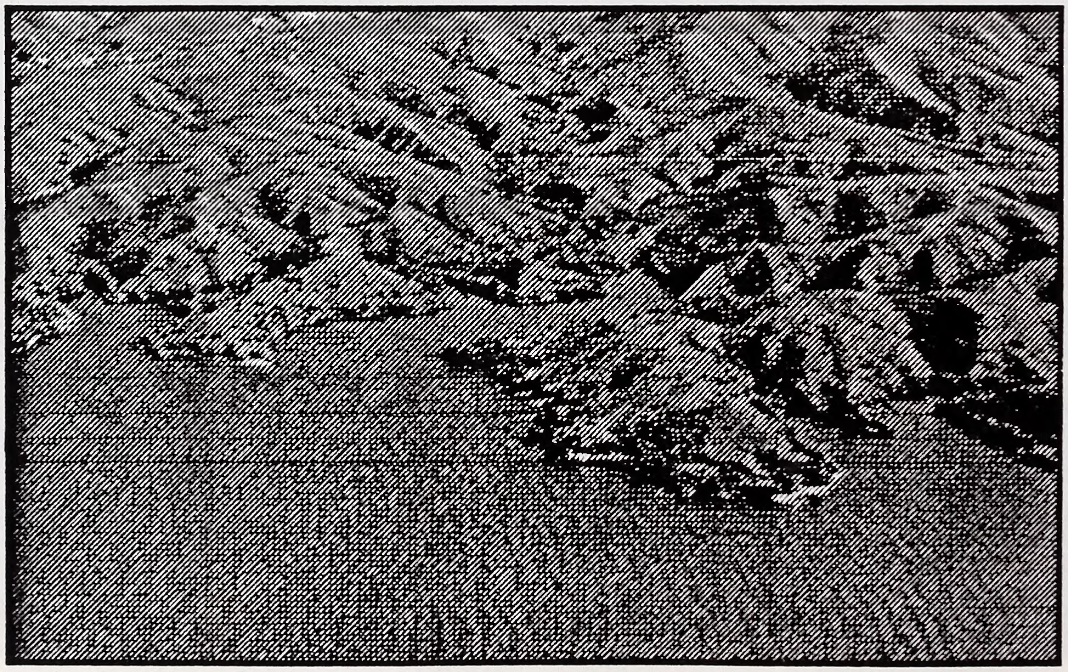
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# LARNED LANDING

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 1
Estimated Hours of Labor: 450
Total Estimated Cost: $15,000

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 0 | Bass Shelters | $ 0 |
| 0 | Catfish Houses | $ 0 |
| 0 | Fish 'N Forests | $ 0 |
| 150 | Tire Towers | $15,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | (volunteer) | $ 0 |

## OTHER STRUCTURES

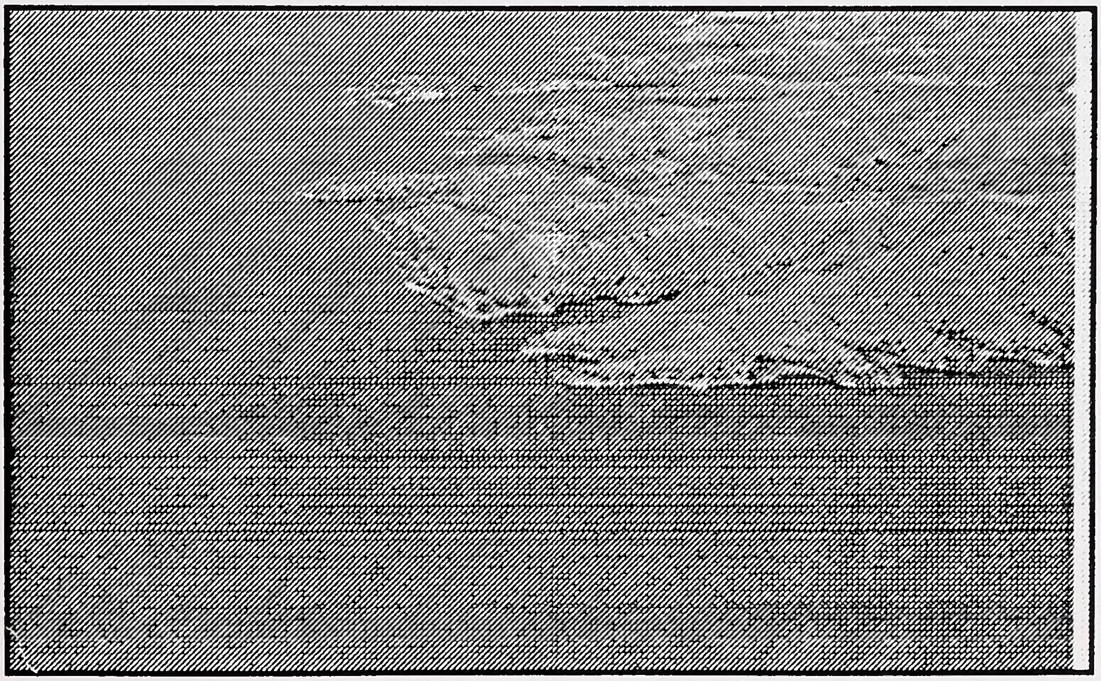
None

## OTHER IMPROVEMENTS

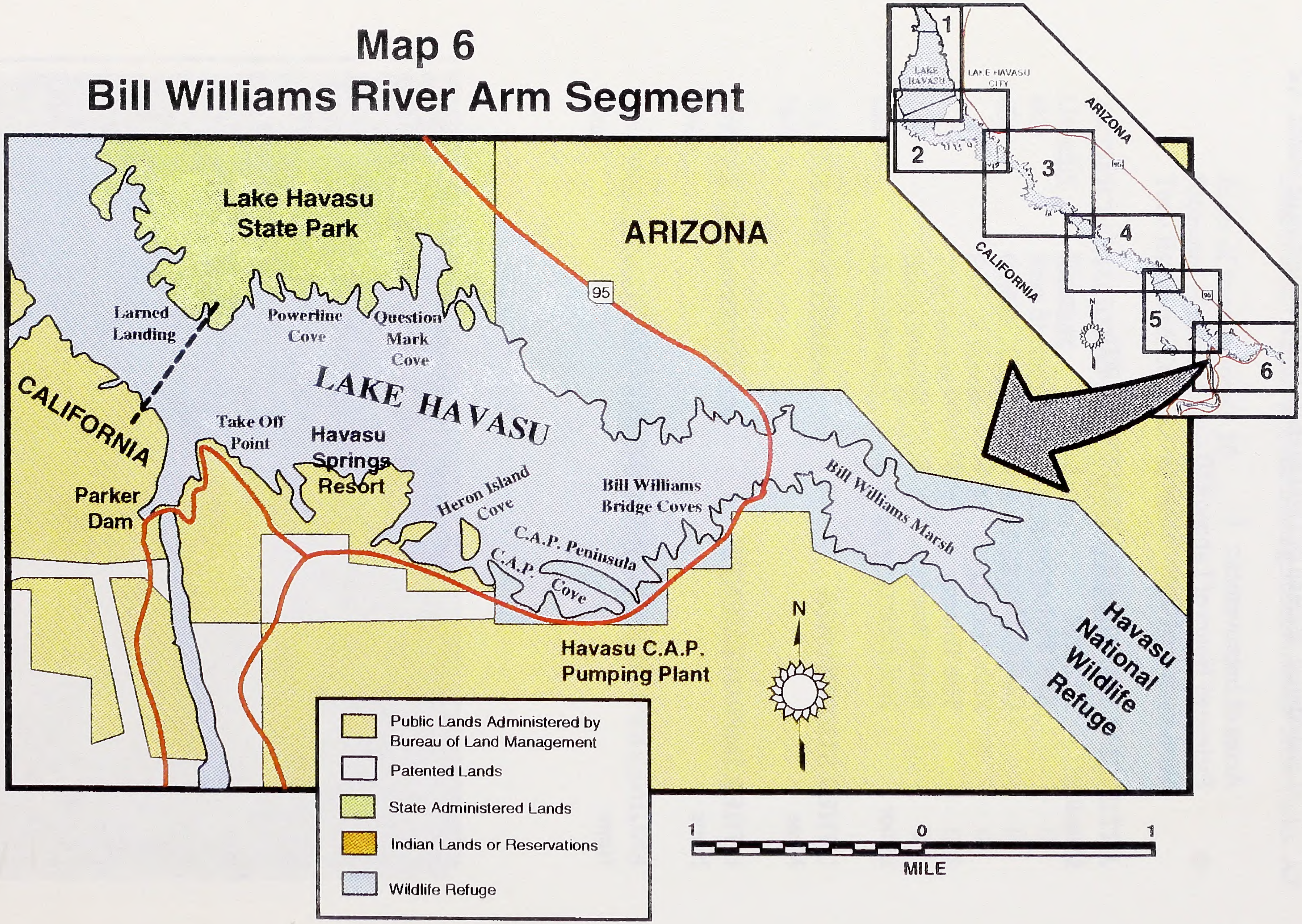
None

## ENGINEERING DESIGN AND CONTRACTING

None



# Map 6
# Bill Williams River Arm Segment



# BILL WILLIAMS RIVER ARM SEGMENT

Acres of Improvement: 45
Estimated Hours of Labor: 19,737
Total Estimated Cost: $2,085,635

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 3,960 | Bass Shelters | $792,000 |
| 2,772 | Catfish Houses | $110,880 |
| 0 | Fish 'N Forests | $ 0 |
| 150 | Tire Towers | $ 15,000 |
| 4,000 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $296,055 |

## OTHER STRUCTURES

| | | |
|---|---|---|
| 1 | Dock | $300,000 |

## OTHER IMPROVEMENTS

| | | |
|---|---|---|
| | Trails (4 miles) | |
| 1 | Parking lot | |
| 1 | Restroom | |
| 1 | Fish Cleaning Station | $458,000 |

## ENGINEERING DESIGN AND CONTRACTING

$113,700

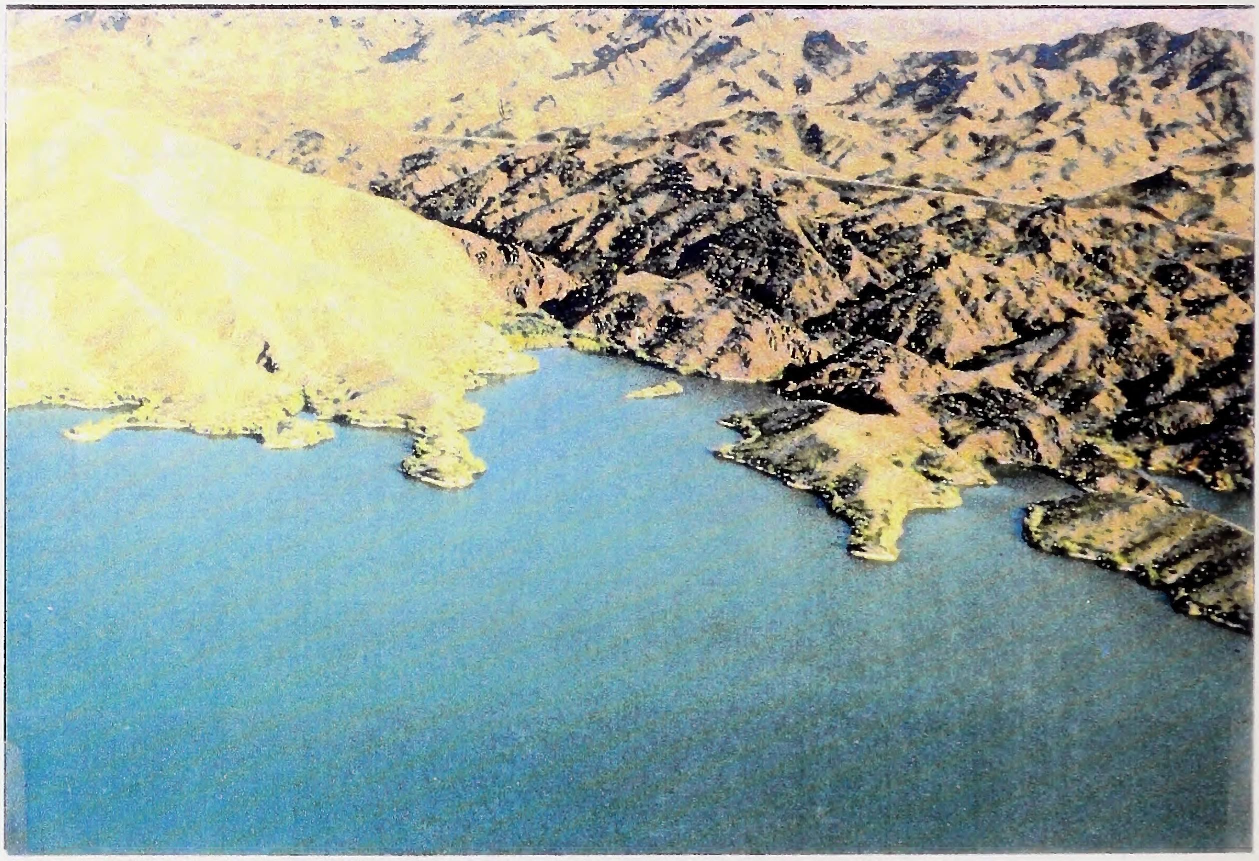
## EQUIPMENT

Necessary equipment such as pontoon boats, 4-WD vehicles, ATVs, generators, shelters, portable cement mixers, camping equipment, etc. are not included. These items will be determined as planning progresses.

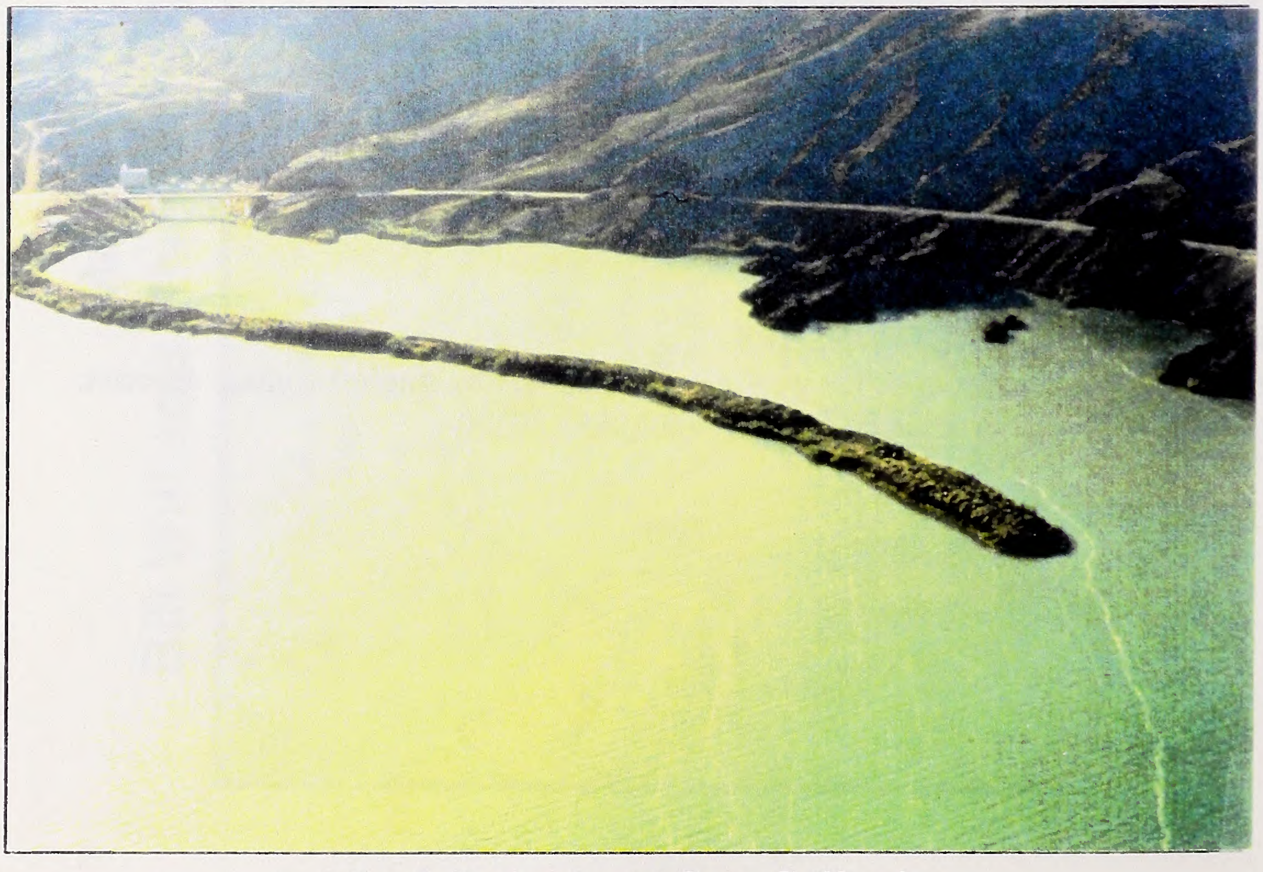
## VOLUNTEERS AND FINANCIAL SPONSORS

Funds and responsible organizations to do the work are being sought by Anglers United. Contact: Dave LaMorte - (602) 839-0660 or Mike Henderson - (602) 855-8017.

# BILL WILLIAMS RIVER ARM SEGMENT



Question Mark Cove, Arizona

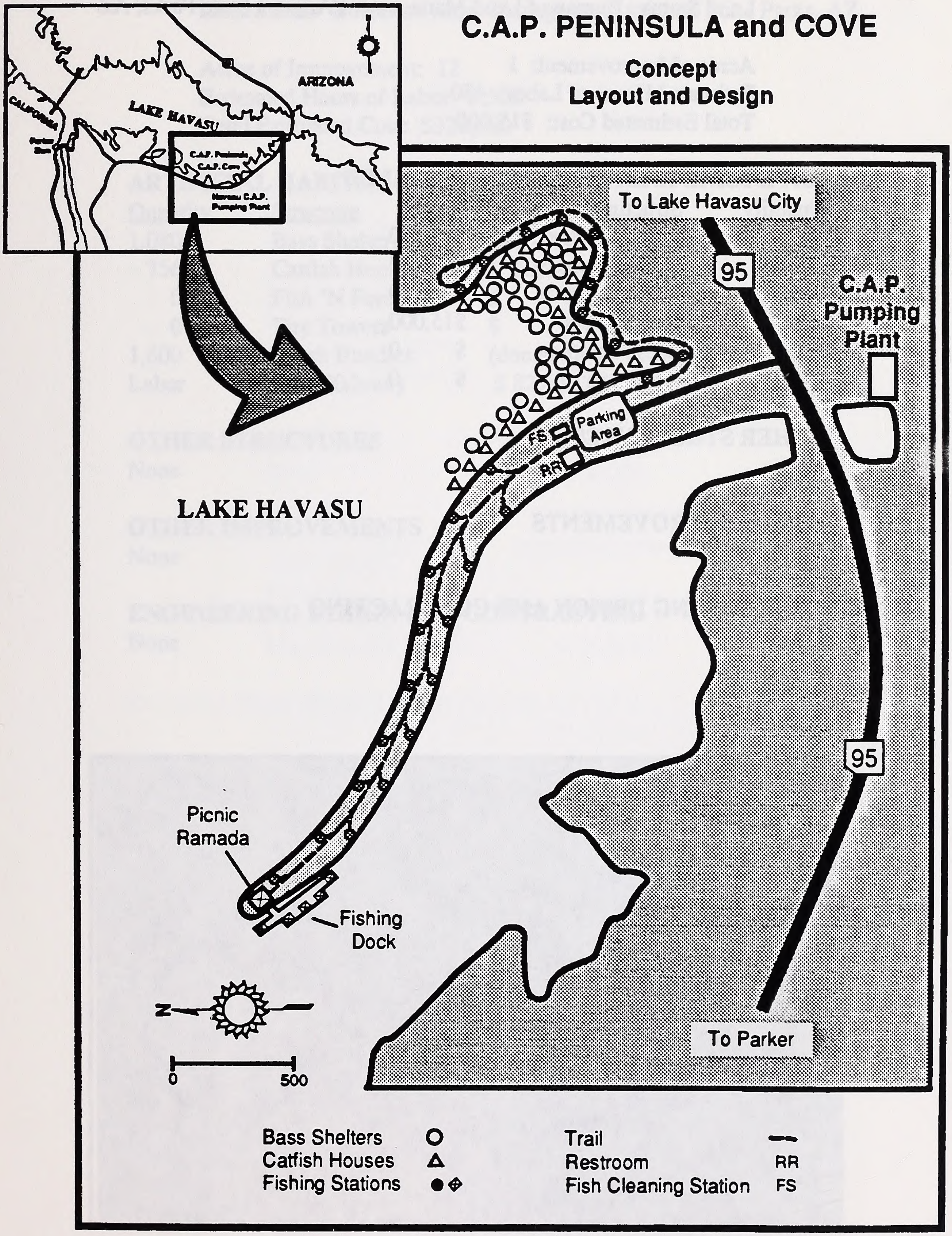


C.A.P. Peninsula and Cove, California

Map 6 Bill Williams River Arm Segment

# C.A.P. PENINSULA and COVE

## Concept
## Layout and Design



# POWERLINE COVES

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 1
Estimated Hours of Labor: 450
Total Estimated Cost: $15,000

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 0 | Bass Shelters | $ 0 |
| 0 | Catfish Houses | $ 0 |
| 0 | Fish 'N Forests | $ 0 |
| 150 | Tire Towers | $15,000 |
| 0 | Brush Bundles | $ 0 |
| Labor | (volunteer) | $ 0 |

## OTHER STRUCTURES

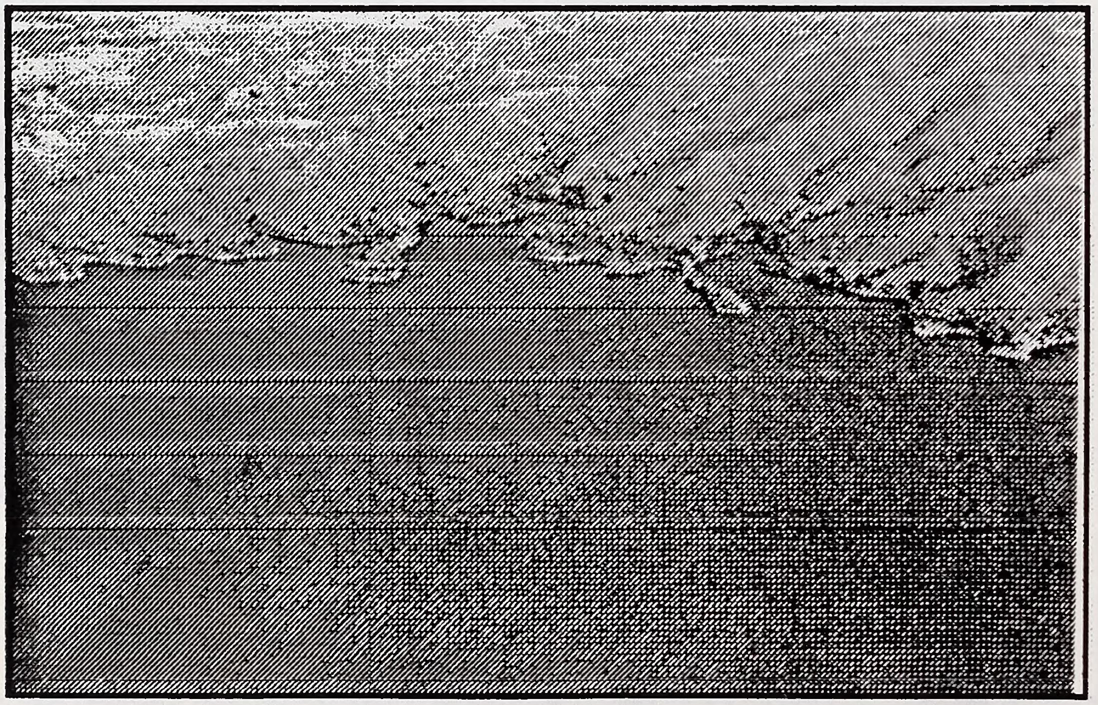
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



## QUESTION MARK COVE

Land Status: Bureau of Land Management/Arizona State Parks, AZ

Acres of Improvement: 12
Estimated Hours of Labor: 5,508
Total Estimated Cost: $328,860

### ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 1,080 | Bass Shelters | $216,000 |
| 756 | Catfish Houses | $ 30,240 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 1,600 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $ 82,620 |

### OTHER STRUCTURES

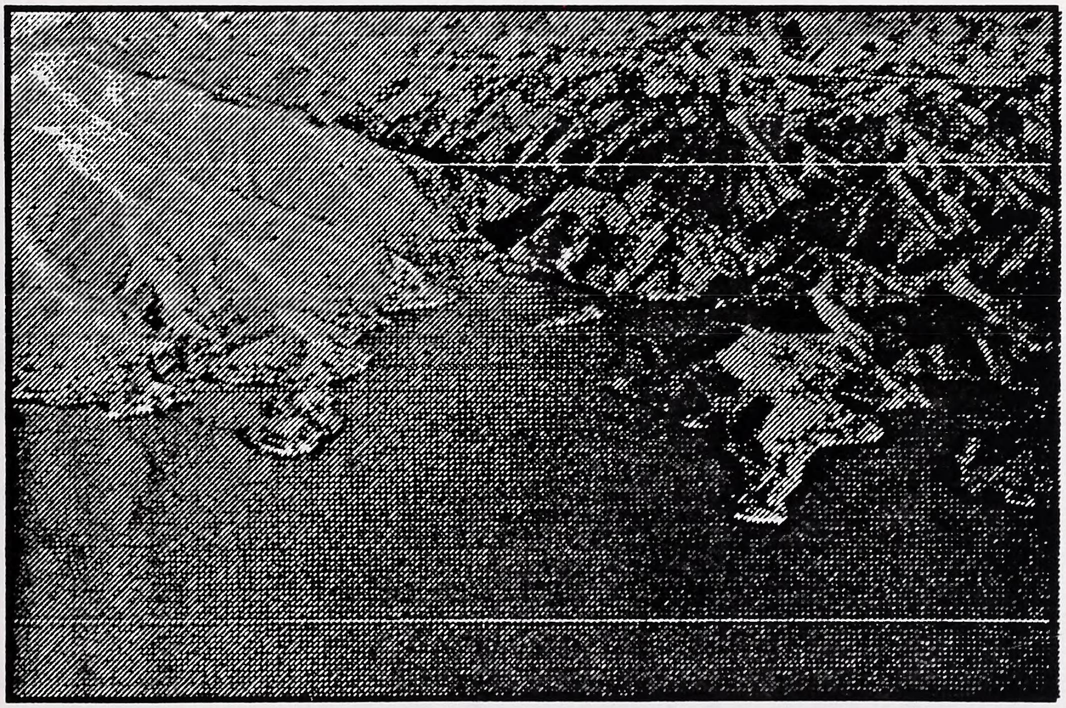
None

### OTHER IMPROVEMENTS

None

### ENGINEERING DESIGN AND CONTRACTING

None



# BILL WILLIAMS BRIDGE COVES

Land Status: Havasu National Wildlife Refuge, AZ

Acres of Improvement: 21
Estimated Hours of Labor: 9,639
Total Estimated Cost: $590,685

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 1,890 | Bass Shelters | $378,000 |
| 1,323 | Catfish Houses | $ 52,920 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 2,400 | Brush Bundles | (donated) |
| Labor | ($15.00/hour) | $144,585 |

## OTHER STRUCTURES

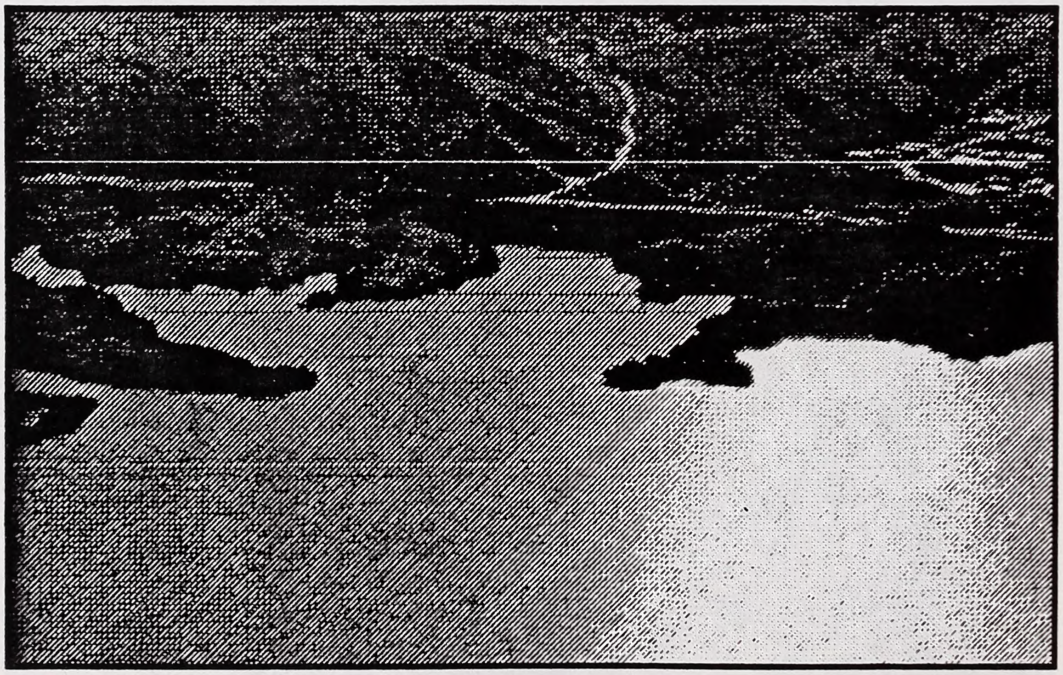
None

## OTHER IMPROVEMENTS

Trails (footpaths) $ 13,200

## ENGINEERING DESIGN AND CONTRACTING

$ 1,980



## CENTRAL ARIZONA PROJECT PENINSULA & COVE

Land Status: Havasu National Wildlife Refuge/Bureau of Reclamation, AZ

Acres of Improvement: 6
Estimated Hours of Labor: 2,754
Total Estimated Cost: $960,230

### ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 540 | Bass Shelters | $108,000 |
| 378 | Catfish Houses | $ 15,120 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $ 41,310 |

### OTHER STRUCTURES

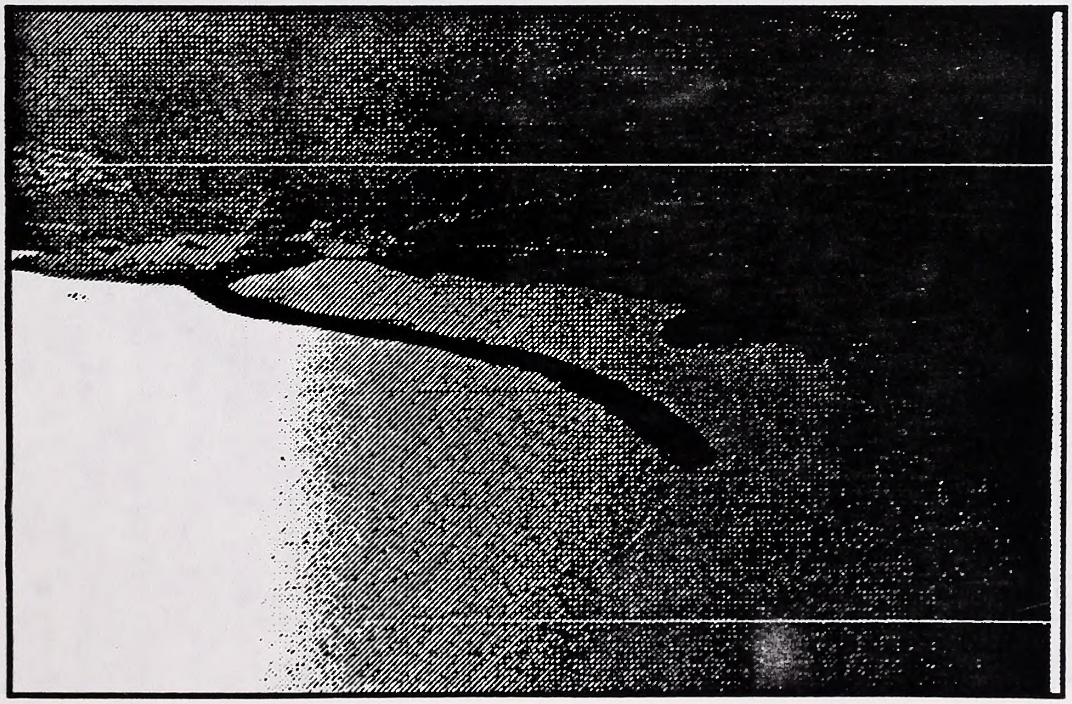
| | | |
|---|---|---|
| 1 | Dock | $300,000 |

### OTHER IMPROVEMENTS

| | | |
|---|---|---|
| | Trails (paved) | |
| | Parking | |
| | Restrooms | |
| 1 | Fish Cleaning Station | $392,0003 |

### ENGINEERING DESIGN AND CONTRACTING

$103,800



# HERON ISLAND COVE

Land Status: Bureau of Land Management, AZ

Acres of Improvement: 4
Estimated Hours of Labor: 1,836
Total Estimated Cost: $109,620

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 360 | Bass Shelters | $72,000 |
| 252 | Catfish Houses | $10,080 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | ($15.00/hour) | $27,540 |

## OTHER STRUCTURES

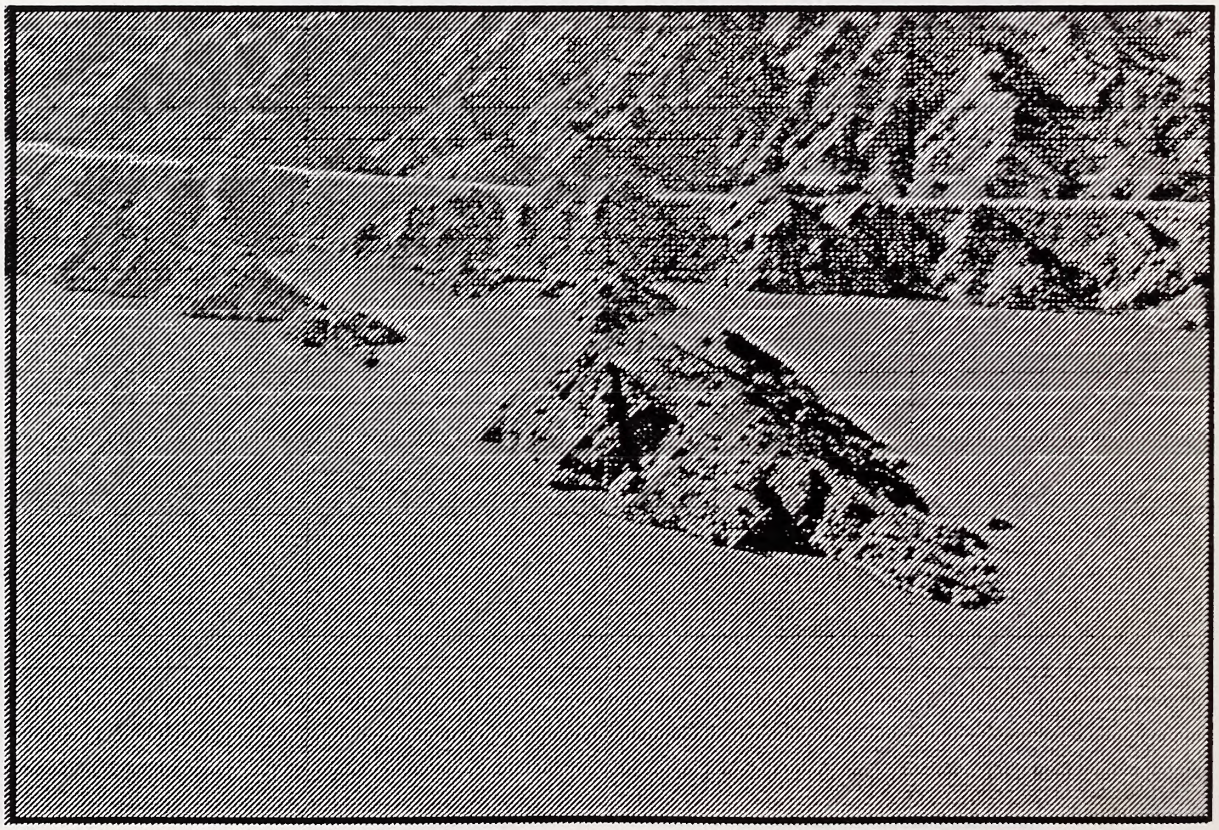
None

## OTHER IMPROVEMENTS

None

## ENGINEERING DESIGN AND CONTRACTING

None



# TAKE-OFF POINT

Land Status: Bureau of Land Management, AZ

Acres of Improvement: 1
Estimated Hours of Labor: 459
Total Estimated Cost: $81,240

## ARTIFICIAL HABITAT TO BE INSTALLED

| Quantity | Structure | Cost |
|---|---|---|
| 90 | Bass Shelters | $18,000 |
| 63 | Catfish Houses | $ 2,520 |
| 0 | Fish 'N Forests | $ 0 |
| 0 | Tire Towers | $ 0 |
| 0 | Brush Bundles | $ 0 |
| Labor | (volunteer) | $ 0 |

## OTHER STRUCTURES

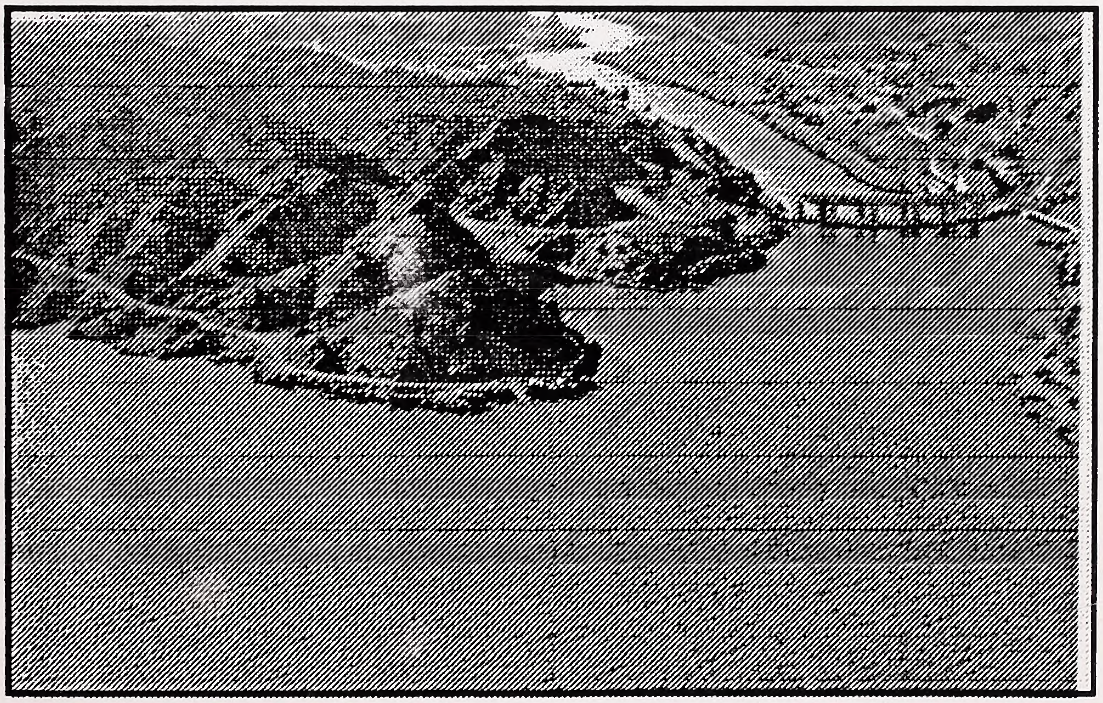
None

## OTHER IMPROVEMENTS

| | | |
|---|---|---|
| | Trails (gravel) | $52,800 |

## ENGINEERING DESIGN AND CONTRACTING

$ 7,920



Marzuola, C., E. Bianchi, Jr., M. Cashman, and J. Garcia. 1990. Angler use and harvest of sport fish in Lake Havasu, California, with specified emphasis on striped bass - Final report. California Department of Fish and Game.

Prince, E. D., and O. E. Maughan. 1979. Attraction of fishes to tire reefs in Smith Mountain Lake, Virginia. In Response of fish to habitat structures in standing water, edited by D.L. Johnson and R.A. Stein, 19-25. North Central Division, American Fisheries Society Special Publication 6.

Reeves, W.C., G.R. Hooper, and B.W. Smith. 1977. Preliminary observations of fish attraction to artificial mid-water structures in fresh water. In Proceedings of the Annual Conference of the Southeastern Assocaiation of Fish and Wildlife Agencies. 471-476.

Unger, I. 1966. Artifical Reefs - A Review. Highlands, New Jersey: American Littoral Society.

Wege, G.J., and R.O. Anderson. 1979. Influence of artificial structure on largemouth bass and bluegills in small ponds. In Response of fish to habitat structures in standing water, edited by D.L. Johnson and R.A. Stein, 59-69. North Central Division, American Fisheries Society Special Publication 6.